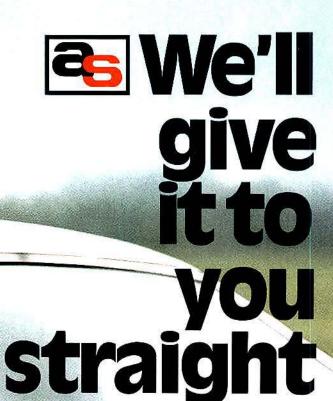
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Mobile Radio Technology

The journal of mobile communications technology

Alternative energy, p. 10

Radio direction-finding 'Swersweeping' SWR Propagation interference APCO wrap-up/review



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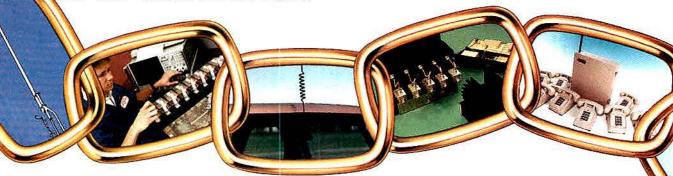
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Mobile Radio Technology

Volume 7, Issue 10

The journal of mobile communications technology

features -

10 Pick alternative energy for remote radio sites

Diana Bjornskov, Onsite Energy
Use alternative energy sources
to take advantage of radio
communications sites that lack
utility power. With redundancy,
natural resource system
reliability may exceed that of
the ac mains.

18 Use direction-finding to trace interference

Joseph D. Moell, P.E. Pick the direction-finding technology you like the best and learn to use it. When the time comes and you have an urgent need to track down a signal, it will be too late if you have not had some practice.

34 Radio direction-finders from \$125 to \$350,000

Don Bishop

From home-grown beam antennas to sophisticated military-grade equipment, radio direction-finding equipment spans a wide range of sophistication, utility and price.

55 APCO wrap-up/review

Frequency coordination fees come down for system operators who reduce interference. Exhibit difficulties prompt the association's president to appoint a task force to come to grips with vendor concerns.

64 Swersweep: A new method of measuring SWR

Joe Peterzak, Europa Marketing Swersweeping helps technicians adjust RF systems faster and to a higher level of performance.

On the cover: An alternative energy source installation on Duncan Mountain in Idaho uses a wind-driven generator and photovoltaics. See Diana Bjornskov's article on page 10.

Use a kit designed to work with a service monitor that includes a tracking generator and spectrum analyzer.

76 Why undesired propagation causes radio interference

Roald Steen

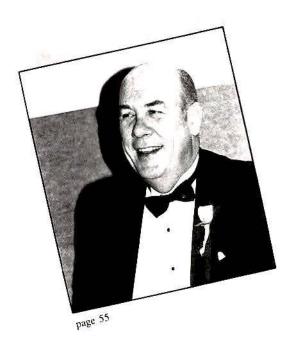
Customer complaints tend to increase during periods of unusual radio propagation. Ionospheric propagation, ducting and knife-edge diffraction may cause interference.

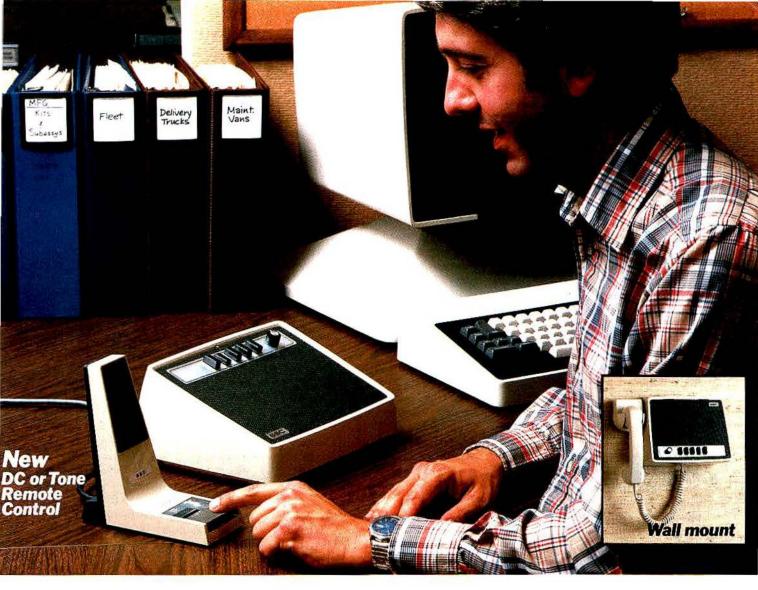
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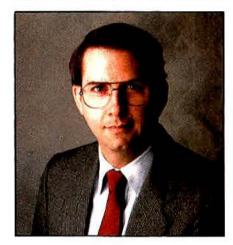


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When the FCC listens to "the private land mobile radio industry," it hears many voices. Among them are trade associations, frequency coordinators, equipment dealers, manufacturers, and occasionally, radio users.

James Kay sells radio equipment in the Los Angeles area. He operates systems licensed in the business and specialized mobile radio services. He is a director of the newly formed American Private Radio Association.

"Radio users don't care about frequency coordination, the FCC and trade associations," Kay said. "They care whether their radios help them do business. They look to dealers to obtain their licenses and solve interference problems, not the FCC or frequency coordinators." Frequency coordinators consist of certain trade associations to which the FCC delegated most of its responsibility for assigning frequencies and resolving interference complaints.

APRA seeks to unite dealers and radio users, including users from all private land mobile radio services. The association's leaders see foul play in the way some trade associations process license applications and handle interference complaints. They see collusion among certain FCC officials, trade associations and manufacturers. Frankly, they do not have much of anything good to say about MRT and other industry publications, either, seeing the trade press as part of a "Washington Inner Circle."

Multiple trade associations

Uniting dealers and users is an ambitious goal. Currently, multiple trade associations represent licensed users, including businesses, state and local government agencies and individuals.

The FCC allocates blocks of radio frequency spectrum according to users' activities. Blocks are assigned for law enforcement, firefighting, conducting business, farming and dispatching taxicabs, for example. Trade associations are motivated to try to restrict eligibility for others to use their members' frequencies and to try to expand their members' eligibility to use other frequencies. Thus, block allocations often pit trade associations against one another.

"We'll do the fighting among ourselves [within APRA]," said the association's president, Mark Dobronski, "Then we'll give the FCC one unified opinion or plan," Dobronski represents the Arizona Department of Corrections, a police and local government radio service licensee.

"APRA will address anything that affects land mobile." Dobronski said. "Frequency coordination is a big issue. But advanced technology is an even more important issue. Sloppy frequency coordination has led to us having to look for advanced technology."

Teletech-APRA

Dobronski's former employer, Teletech, a Dearborn, MI-based engineering company, lost \$250,000 or more of annual revenue when the FCC delegated frequency coordination responsibilities exclusively to trade associations in 1986. Previously, the company sold field studies to users who chose not to use the services of frequency coordinators. With the loss of revenue, "Teletech no longer could afford me," Dobronski said.

The Teletech-APRA connection is strong. For example, not only is Dobronski a former employee, his wife is president of Teletech. Teletech vice president Kenneth Hoehn is an APRA director. The first two issues of the association bulletin, APRA News, feature front-page editorials about Teletech's request that the FCC decertify NABER as a frequency coordinator because of NABER misconduct alleged by Teletech.

Whether the Teletech-APRA connec-

tion and the association's tendency to operate from the shadows will work in its favor remains to be seen.

Dobronski, Hoehn and another APRA director, Steve Black, are wary of trade press coverage. One director withheld comment about the association. Reasons they gave range from distrust of the trade press to fear of reprisals that may be exacted by frequency coordinators by intentionally mishandling license applications submitted by APRA leaders.

Requests we made for a list of APRA's nine directors went unfulfilled. The APRA News offers no hint as to the identity of the association's directors and officers, and we can tell you from experience that they are not easy to find.

We cannot endorse APRA because a clear picture of the association has not emerged yet. We do like two of the the association's goals: to offer a unified voice representing private land mobile radio users before the federal government and to improve the frequency assignment process so radio communications equipment dealers can serve their customers better.

Happy birthday, Fred!

MRT's industry consultant, Fred M. Link, turns 85 this month. If you would like to send him a card, you can send it to: "Fred M. Link, in care of Mobile Radio Technology, P.O. Box 12901, Overland Park, KS 66212."

We at MRT count Fred among our many blessings, and wish him many happy returns.

-Don Bishop

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Volume 1. No. 4

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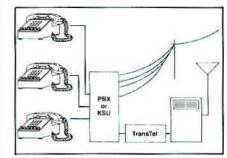
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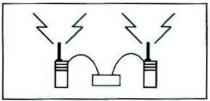


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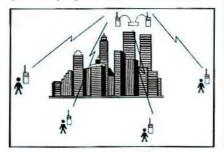
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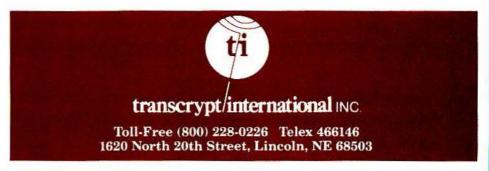
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etters to the editor

Vehicular repeaters:

In your August 1989 issue, I read the article "Universal Vehicular Repeater Extends Portable Range" by Wes Sutton. I am not an electronics technician or engineer, but generally I understood the article.

I am writing to you to obtain more information regarding mobile vehicular repeaters, their efficiency and cost.

The information I seek is for the Austin Independent School District Campus Police. We are experiencing some difficulty with communications between our hand-held transceivers and base station. When officers try to transmit within a large school building made of steel and other metal, it is virtually impossible to receive their signals.

We use Uniden mobile and hand-held transceivers, and I am interested in vehicular repeaters that are compatible.

We use two repeater stations on opposite sides of the city to cover 261 square miles. Within the district there are 120 schools and administrative offices. When an officer is away from his mobile unit, there is only a 10% to 15% chance that he can communicate with the base station from outside a building and nearly no chance at all that he can communicate from inside a building. The situation, as you can see, has the potential to be life-threatening.

I would like to receive information from suppliers who might read this

Bill Ferris Operations Captain Austin Independent School District Campus Police 5900 Guadalupe Austin, TX 78752

The Battle of La Mosca:

After reading your editorial, "The Battle of La Mosca," in the August 1989 issue, I must respond "for the record." Your comments and statements are, in the majority, correct. The following is offered to bring the entire picture into focus

The U.S. Forest Service in Albuquerque, NM, has enjoyed a lengthy working relationship with All-Comm; its vice president, J.H. Ericksen; and many other two-way radio service providers in the area. Through this working relationship, many controversial electronic site issues have been resolved.

The case of La Mosca is no exception. great many-not just a fewindividuals, including those with administrative and technical responsibilities, were involved with the successful resolution of the La Mosca conflict.

Most, if not all, federal agencies, such as the Forest Service and the Bureau of Land Management, are two-way users at electronic sites. Some of these sites include high-power broadcast transmitters that emit continuous carriers. Thus, we and other federal agencies experience many of the same problems experienced by commercial two-way radio

Mobile Radio

The journal of mobile communications technology

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Letters to the editor

service providers.

The Forest Service is intimately and at times painfully aware of the consequences of mixing high-power and lowpower transmitters on our extremely "quiet" electronic sites found in most of the western states. For many years, the Forest Service has pursued, through electronic site management, the isolation of high-power and low-power users

by using horizontal and vertical sepa-

The West, compared to the eastern United States, is blessed and cursed with "tall towers" in the form of mountains managed by government agencies. Not all mountaintops allow the most desirable isolation-Sandia Peak near Albuquerque is an example. When less desirable isolation must be tolerated,

some compromises and technical solutions need to be reached to the satisfaction of all users of public lands. Satisfaction is not possible at all electronic sites but a conscientious effort to achieve it is pursued by many parties.

The consultant we hired, Shaffer & Associates, stressed in its final report that La Mosca's geometry and geography make it unique and that La Mosca does not represent all western electronic sites. The site geometry issue primarily dictated the consultant's findings.

The site geometry and geography fixed the "main" lobe of the proposed broadcast transmitter directly into the buildings and antennas of all existing users. The position of the main lobe and the Forest Service's desire to retain La Mosca as an exclusive low-power site as stated in the Forest Site Management Plan were the determining issues in the denial of the broadcaster's application.

It was All-Comm's persistence and knowledge of the surrounding area that allowed All-Comm to present an alternative to the broadcaster. All-Comm proposed an alternative site outside the Forest Service land and 1.5 miles away from the existing electronic site. The proposed site had been overlooked by the broadcaster's engineers.

To my knowledge, the broadcaster has not pursued the development of the alternative site.

E.C. Flanders Jr. Regional Telecommunications Manager U.S. Department of Agriculture Forest Service Southwestern Region Albuquerque, NM

Fast Fact Card comment:

The toughest problems encountered on the job are:

(1) obtaining zoning for a cell site in the neighborhoods with the most cellular users. The more expensive the neighborhood, the more the demand for cellular, but also the tighter the zoning restrictions.

(2) Confining actual coverage to the 39dBμ "legal" contours.

Cathi Mitchell Communications Engineer U S West/NewVector Phoenix



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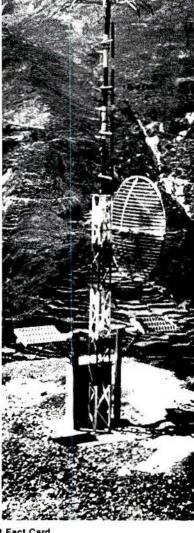
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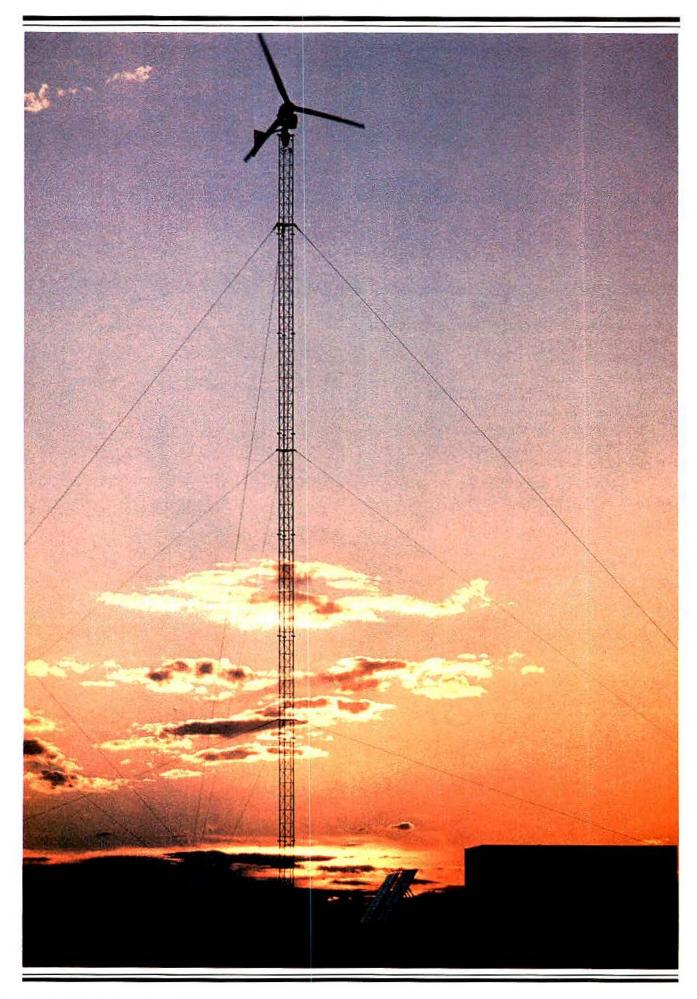
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Pick alternative energy for remote radio sites

Use alternative energy sources to take advantage of radio communications sites that lack utility power. With redundancy, natural resource system reliability may exceed that of the ac mains.

By Diana Bjornskov

Electrical power, a resource taken for granted in urban areas, can be more difficult to obtain in rural areas and on mountain peaks. Advance planning for reliable electricity in rural areas and at remote sites can help reduce implementation costs and prevent disappointing results.

Primary power from alternative sources-solar, wind, thermal, electric, mechanical and hybrid systems-is as reliable or more reliable than utility power when it is designed for a specific site. Utility power has some disadvantages in rural areas and can be far more costly to build and maintain.

The Telecom Energy Services group of Onsite Energy conducted research that shows power requirements for remote telecommunications and radio communications networks vary greatly and cannot always be satisfied by utility service providers. Rural grid connection can be economically unfeasible and unreliable.

Three installations that have provided constant wind-generated and diesel fuelgenerated primary power in southwestern Alaska since 1986 are in the remote Arctic where 80mph wind is common. Corrosive salt spray from ocean air, frequent below-freezing temperatures, high transportation and fuel delivery costs offer singular challenges to the power system supplier.

These sites bring reliable telecommunications to their region. Their configurations withstand severe weather

Bjornskov is an account manager for the Telecom Energy Services group of Onsite Energy, Portland.

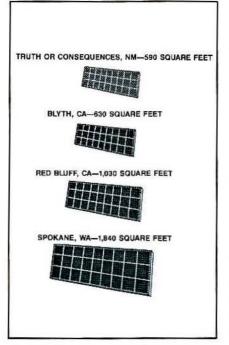


Figure 1. Photovoltaic panel areas required for 1,000W primary power systems.

conditions and provide the lowest operational and maintenance costs.

Energy requirements were assessed, and environmental conditions and available natural resources were identified. Then the power systems were sized. Combinations were analyzed and paired with site data until the right arrangement of hardware was achieved. The same procedure applies for any climatic con-

Photovoltaic power was not the correct year-round solution for Alaska because of the many months of limited sunlight and darkness every year. Wind, though, is reliable and fairly constant.

Wind and diesel fuel were chosen to drive generator sets to power the sites.

Wind-turbine generators deliver more than half of the annual power requirements, ranging from more than 80% during some months to as little as 20% during others.

February's -60° weather did not faze the wind generators, but fuel jelled in a diesel generator. Wind and battery power carried the load; customer service was not interrupted. The abnormal conditions surprised everyone. To prepare for a recurrence, adding fuel tank heaters is under consideration.

In Idaho, a combination photovoltaic, wind and diesel system was built four years ago to power a radio communications and microwave telephone site. At the telecom provider's request, the system made use of existing diesel generators. New photovoltaic panels and new wind-turbine generators were installed.

The integrated system has performed remarkably well: Sunlight and wind provide more than half of the annual power requirements. But the aging diesel generators had to be replaced last

To prevent downtime for unplanned maintenance or for retrofitting, and to avoid using incompatible equipment, systems should be configured with new components.

The dollar value of fuel savings depends on delivered costs. The savings were substantial in these three examples, as they usually are for a remote area. Saving diesel fuel cost is only one advantage. In addition, using alternative energy sources extends fossil-fueled equipment life and extends the interval between fuel deliveries.

Reasons to use alternative primary power

- Achieve optimum coverage by selecting the most advantageous site regardless of utility power availability.
- Reduce capital investment and life-cycle costs.
- ☐ Build complete redundancy into the system, and own that redundancy.
- Avoid logistical ordeals often associated with uneven terrain.
- Reduce encounters with environmental and regulatory restrictions.
- Control the entire hardware system.
- Add the power source to the balance sheet as a depreciable asset.

Determining the appropriate energy source and system type for a given region requires information:

- resources available at the site.
- · microclimatic conditions.
- · environmental requirements.
- · costs for locally delivered fuel.
- size and nature of the loads.

The availability of "natural" energy

resources such as sunlight and wind depends upon weather and topography. For example, at one location, wind might provide most of the necessary power. At a location 100 feet away, it might provide only a fraction of that power.

Photovoltaic panels require sufficient land. If land is expensive and sunlight

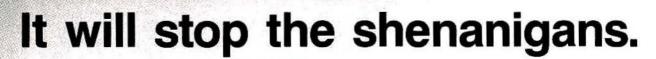
is limited, the large array and large tract of land required to expose photovoltaics to enough light could make the site unreasonably costly.

Figure 1 on page 11 shows the approximate area that photovoltaic panels require in several areas of the country to produce IkW of electricity.

Calculations used to size Figure 1's panels assume that panels with the highest efficiency currently available are used. Microclimates within any topographic area may increase or decrease photovoltaic efficiency, as well as any other natural power resource.

Photovoltaic and wind-driven systems offer highly reliable, clean power. They cannot power a site that demands constant power unless the natural resource is available constantly.

Nevertheless, sunlight and wind can contribute generously as part of a hybrid system to reduce generator fuel costs by half or more. Considering fuel prices, delivery costs and the advantages of reducing generator running time and maintenance, savings can be substantial.





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Alexander

As far as power equipment is concerned, there is no magic except for education and experience in system integration. Here are some of the pros and cons:

• Engine generator sets—If built for the reliability and durability necessary to serve remote locations or to endure weather extremes, engine generator sets remain a good choice for dependable primary power. A word of caution: Some generators are designed only for standby power. They cannot support loads at a radio communications site over extended periods.

• Diesel fuel—The advantages of using a generator powered by diesel fuel include the generator's relatively low capital cost; an extremely wide selection of power capacities; independence

from climatic conditions; and predictable performance.

A diesel-fuel generator performs well in hybrid systems that include wind and solar power. As a stand-alone source, it can be configured to use fuel efficiently.

• Thermoelectric generators—With no moving parts, thermoelectric generators are highly reliable and easy to maintain. Their modular design means they can be connected in multiples to provide higher power capacities.

But they are inefficient, and they require frequency refueling with propane. Propane must be delivered by trucks, so delivery may be affected adversely by harsh weather conditions.

• Closed-cycle vapor turbines— Where fuel is readily available, closed-cycle vapor turbines may be used. Their capital cost per watt is high. Their operational life is about 20 years, with a mean time between failure of more than 30,000 hours.

These turbines are extremely reliable and operate on a variety of fuels. Fuel efficiency is low, so frequent deliveries may be required. In remote areas, the required delivery schedule may be expensive or impossible to manage because of severe weather.

System integration

Remote sites usually are unattended and may be difficult to reach. Thus, an independent power system must have greater redundancy than an equivalent utility power system. Adequate redundancy is assured by determining loads correctly and by applying the right technology to support those loads.

Seasonal changes are likely to affect energy use. Power system design should take into consideration fluctuations in outside air temperature and resulting changes in heating, ventilation and air conditioning requirements. A controller can regulate outside air used for cooling when weather conditions permit reduced energy use.

A controller with a microprocessor can monitor and regulate the system. It monitors fuel levels; engine status; battery set voltage and temperature; load current; charging current; and shelter conditions. Shelter conditions include air temperature and intrusions. Programmable controllers allow a monitoring routine to be configured for a site's unique requirements.



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In Canada: Eastcom Industries, Ltd. • 430 Signet Drive Weston, Ontario M9L 2T6 • (416) 743-7801 It is not unusual for maintenance technicians to visit a radio communications site once a week or more to check equipment. Such frequent visits may be impossible if a site is snowbound or otherwise inaccessible.

To meet the problem of limited access, some radio system designers overbuild a remote site to allow for channel attrition during periods when the site is inaccessible. Although the desirability of overbuilding is debatable, overbuilding unquestionably has an effect on the load size and, therefore, energy use, fuel expenses and land costs for solar panels. Overbuilding an already redundant power system is not economical.

The need for preventive maintenance should be kept to a minimum by installing the correct power system in the first place. Thereafter, preventive maintenance should be required only once or twice a year.

Comparing alternatives

 Utility power—If utility power is available locally, it may be preferred because it is a known quantity and low in cost. Yet it is important to consider the following issues when deciding about electricity:

A power distribution extension may not be available without extensive (and expensive) right-of-way agreements, leases and easements. Line extensions from the closest distribution service to the top of a hill or mountain cost \$2 to \$26 per foot. Buried line costs more than overhead line. Some utilities require the customer to provide a trench. The excavation cost is extra.

After the utility power is installed, it must be maintained. Maintenance may be at the customer's expense. Maintenance costs vary, but a figure of 6% of the capital cost of the line is typical. Emergency repair is an extra cost. Troubleshooting buried line is expensive.

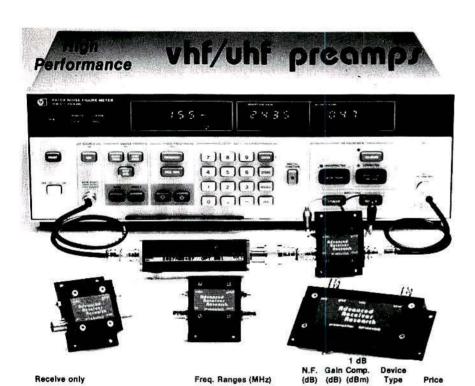
In many rural areas, overhead lines are banned because of potential lightning strikes and fire. The Environmental Protection Agency, the Bureau of Land Management, state and local government, fire marshals and other government agencies have requirements regarding the placement of overhead and buried power lines.

In some jurisdictions, trenches must be dug in a manner that carefully parts the earth so it may be returned to its original position with its surface growth undisturbed.

Overhead power lines can be a menace to wildlife and people alike, if a live conductor falls during a storm.

From time to time, stories appear in local newspapers about birds and squirrels causing breakers to trip and fuses to blow, interrupting electrical service. The customer usually pays to have service restored.

• Natural resource—The cost of installing a redundant, reliable, turnkey primary power system at remote sites usually costs less than providing electricity by other means. It is a good idea to obtain a comparative bid, unless utility power is readily available.



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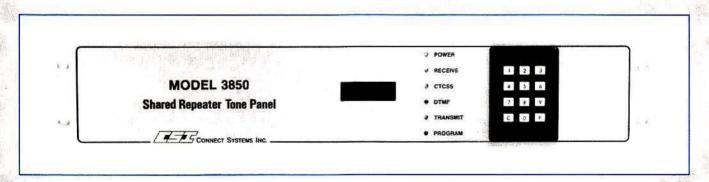
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- Barge in E/D
- · Squelch tail duration
- Deadbeat disable
- Stuck MIC activity timer
- · Hog-time penalty
- Courtesy beep E/D

NOTE: E/D = enable/disable

AND THE BOTTOM LINE?...ONLY \$449

Use direction-finding to trace interference

Pick the direction-finding technology you like the best and learn to use it. When the time comes and you have an urgent need to track down a signal, it will be too late if you haven't had some practice.

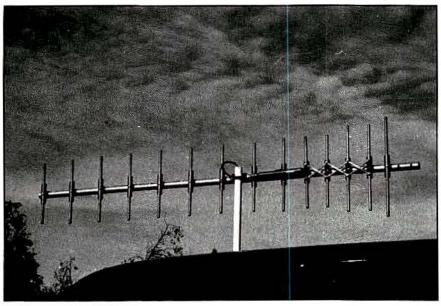


Photo 1. A simple, inexpensive way of taking a bearing to a signal from a mobile unit. This broadband yagi gives first-rate results from 450MHz to 470MHz. It rotates on a mast that protrudes from the vehicle win-

dow or through a hole in the roof. As the beam antenna is turned, usually by hand, a signal strength meter (S-meter) on the receiver indicates when the antenna points in the direction of the strongest signal.

By Joseph D. Moell, P.E.

There it is again! That strange carrier, interfering with your radio system. There is no modulation to identify it. Where is it coming from? How do you find the source?

Radio direction-finding (RDF) techniques used to trace the source of interfering signals were developed in the

Moell is head of the Transmitter Subsystems Section at Hughes Aircraft, Fullerton, CA. He is coauthor of Transmitter Hunting-Radio Direction Finding Simplified (stock No. 2701): TAB Books, Blue Ridge Summit, PA 17294-0214. The 323-page handbook includes practical techniques and circuits for RDF.

early days of radio communications. Today, the military, the FCC and search and rescue agencies, such as the Civil Air Patrol and the U.S. Coast Guard, make heavy use of RDF.

Few radio shops are well equipped for efficient RDF. But you, as a radio technician or system operator, can put RDF to good use on your own behalf or on behalf of agencies and other customers you serve. Here are some ex-

 Stuck transmitters—Whether caused by equipment malfunction or by a user who sits on a hand mic, a continuous carrier on your frequency may halt all communication. The source must be

found-fast. If automatic number identification is not in use and no audible clues are heard, multiple-site RDF makes tracing the source much easier.

- · Stolen radios-It is not uncommon for a lost or stolen hand-held or mobile radio to appear on the air, causing interference and harassment. An RDF network provides the best chance of rapidly stopping the interference and recovering the radio.
- · Surveillance-RDF can locate criminals who use radios to coordinate their activities. Vehicles and sensitive cargo can be tracked on the move, without exposing officers to view. Tiny, remotely activated "bumper beeper" transmitters serve the purpose.
- · Lost individuals-Mass media publicize the use of RDF to track emergency locator transmitters (ELTs) carried by aircraft and emergency position indicating radio beacons (EPIRBs) carried by boats. But sometimes, lives must be saved by tracking other transmitters.

Last year, when a single-engine airplane crashed in rugged terrain west of Denver, its avionics were destroyed and its ELT failed to activate. The pilot and passenger, both radio amateurs, used hand-held amateur VHF transceivers to call for help.

Three other amateur operators skilled in RDF quickly used their directionfinding equipment to determine the airplane's location. Evacuation of the two crash victims was complete within six hours.

 Intermod products—Although you may be able to listen to the offending intermod signal and identify the two-ormore mixing frequencies from the in-

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1060 Salk Road Unit 6 Pickering, Ontario, Canada L1W 3C5 (416) 839-5911 • Fax: (416) 839-2529 formation it carries, knowing the frequencies does not necessarily pin down the source.

In Southern California, a strong mixing product interfered with a communications satellite downlink. The signal's components came from a noncommercial FM station and a VHF TV station's aural carrier. Both stations are on mountaintop sites. But RDF showed

that the mix occurred at an industrial area 25 miles from the mountain!

Calling for help

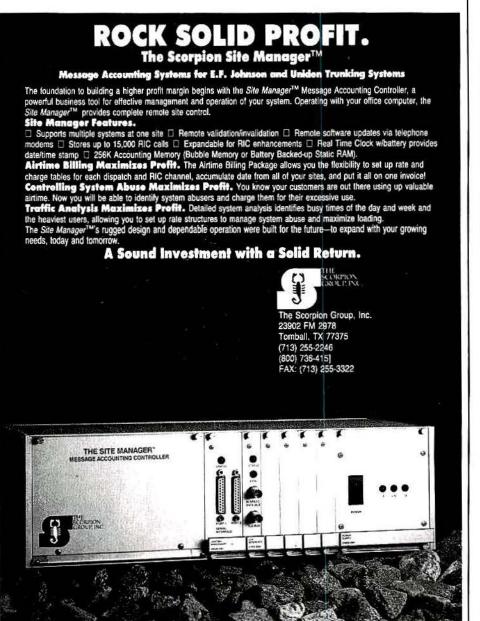
Why not just call the FCC for direction-finding service? The commission's field offices have sophisticated RDF equipment for many frequencies.

Unfortunately, the agency cannot guarantee a rapid response. Staff reduc-

tions and higher-priority requests for RDF capability, such as those involving critical government communications, may make the FCC's RDF capability unavailable to you when you need it.

It is far better to be prepared to hunt interference sources on your own.

You can simply wander around your coverage area, listening for a strong signal to indicate the transmitter you seek is close by. That is the so-called "hot-cold" method of transmitter hunting. A better name would be the "needle-in-a-haystack" method. It is not radio direction-finding, because there is no indication of direction. You need something that gives a bearing to the signal—a directional antenna—and you may have one already.



Circle (17) on Fast Fact Card

FCC enforcement priorities

- White House and presidential communications
- Communications involving safety of life and property
- Public safety and commercial communications
- ☐ Other

Yagi and quad antennas (beams)

Photo I on page 18 shows a simple, inexpensive way of taking a bearing to a signal from a mobile unit. Mount a yagi or cubical quad antenna on a rotating mast that protrudes from the vehicle window or through a hole in the roof. As the beam antenna is turned, usually by hand, a signal strength meter (S-meter) on the receiver indicates when the antenna points in the direction of the strongest signal.

Aluminum yagis are readily available and easily mounted. You may have extra yagis that can be pressed into service.

Quad antennas (See Photo 2 on page 22) can be made of stiff copper wire and PVC plastic pipe. Construction time is about two hours, plus time to modify the vehicle to attach the rotating mast and some sort of pointer and compass rose at the mast base.

The larger the beam, the better the bearing resolution. Usually four ele-

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MITSUBISHI		45.00	00.00	00.75	54 50	
900 (Portable)	WP-300-900		36.00	33.75	31.50	
800 (Transportable)	WP-301-800	54.00	43.00	40.50	37.80	
MOTOROLA						
6000, 8000 Series (Light Gray)						
Standard (7.2v @ 1.1 AH)	WP-100-6000		39.96	37.96	34.97	
Standard (7.2v @ 1.3 AH) Equivalent to XT	WP-100A-6000		44.00	41.25	38.50	
Heavy Duty (7.2v @ 2.2 AH)	WP-101-6001		71.96	67.46	62.97	
Heavy Duty (7.2v @ 2.6 AH)	WP-101A-6001		79.96	74.96	69.97	
Battery Eliminator (Light Gray)	WP-102-6010	69.95	55.96	52.46	48.97	
9000 Series (Dark Gray)						
Standard (7.2v @ 1.1 AH)	WP-103-9500		39.96	37.96	34.97	
Standard (7.2v @ 1.3 AH) Equivalent to XT	WP-103A-9500		44.00	41.25	38.50	
Heavy Duty (7.2v @ 2.2 AH)	WP-104-9501		71.96	67.46	62.97	
Heavy Duty (7.2v @ 2.6 AH)	WP-104A-9501		79.96	74.96	69.97	
Battery Eliminator (Dark Gray)	WP-105-9510	69.95	55.96	52.46	48.97	
NEC						
9100 Series (Portable)	WP-200-9000	59.95	47.96	44.96	41.96	
9A Series (Portable)	WP-200A-9A	59.95	47.96	44.96	41.96	
Battery Eliminator (9100)	WP-201-9000	69.95	55.96	52.46	48.97	
Battery Eliminator (9A)	WP-201A-9A	69.95	55.96	52.46	48.97	
NOKIA-MOBIRA						á
500 Series (Portable)						
(7.2v @ 1000 MAH)	WP-400-500	45.00	36.00	33.75	31.50	
Cityman (Transportable)				10-0-01-10-1		
(9.6 v @ 1100 MAH)	WP-401-500	54.00	43.20	40.50	37.80	
(9.6 v @ 1300 MAH)	WP-401A-500	59.00	47.20	44.25	41.30	
OKI						
700 Series (Portable)	WP-500-700	45.00	36.00	33.75	31.50	
PANASONIC			30.00	DOI: O		
EB-3W (Portable)	WP-600-EB3W					
	W-2312	30.05	31.96	29.96	27.97	
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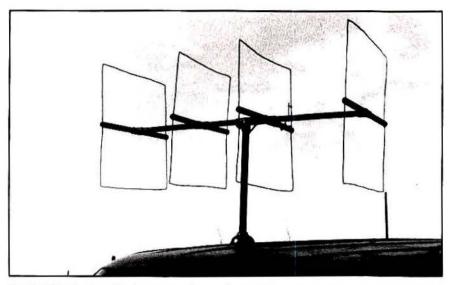


Photo 2. Cubical quad antennas can be made of stiff copper wire and PVC plastic pipe. Construction time is about two hours, plus time to modify the vehicle to attach the rotating mast and some sort of pointer and compass rose at the mast base.

ments on VHF highband is a reasonable number for suitable bearing accuracy and ease of turning. Frequency bandwidth for adequate directional performance is no greater than 10%. Thus, more

than one beam antenna may be required to cover all frequencies.

You need an S-meter on the receiver to determine accurately when the beam is pointing at the signal source. External S-meters can be added easily to receivers that do not have them.

Because FM receivers saturate in the presence of extremely strong signals, an external attenuator is a must. The attenuator reduces signal input to the receiver as you come closer and closer to the signal source.

Polarization

The orientation of the yagi elements and of the quad's feedpoint determines polarization. Your RDF beam must be polarized the same as the signal source to reduce adverse effects of multipath reflections.

Most land mobile transmitters use vertically polarized antennas. But intermod mixing points and transmitters in the broadcast and other services may have predominantly horizontal polarization. Make provisions for rotating the antenna boom to select between vertical and horizontal polarization as necessary.

The main advantage of a gain RDF antenna is its high sensitivity. When the signal is weak, a beam antenna outper-



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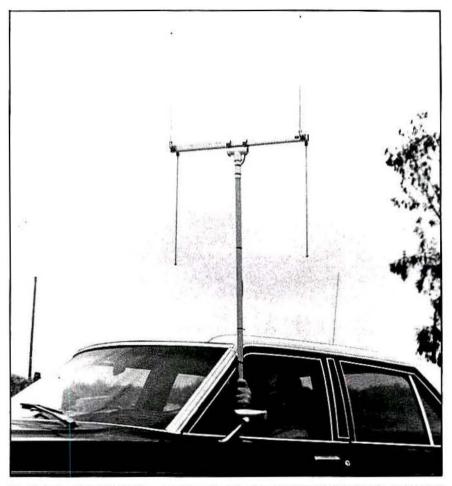


Photo 3. Homing RDF units use a pair of vertical antennas at the ends of a horizontal boom. The antennas are separated by less than a half-wavelength. The SuperDF made by BMG Engineering works on foot, or can be used this way on a vehicle.

forms other RDF methods. When you must find the source of a feeble spurious emission that just barely holds your hilltop receiver open, the beam antenna is your best bet.

Beams are unsuitable for use below 100MHz. Yagi elements for 33MHz VHF lowband are about 14 feet long. That length is not practical for the average squad car!

Other problems associated with beams are their requirement for manual turning. Manual turning, together with the usual signal flutter in mobile service, makes taking bearings a practiced art, particularly on intermittent signals. Having two individuals, one to drive and one to rotate the antenna, gives maximum efficiency.

Homing-type RDF sets

Homing RDF units use a pair of vertical antennas at the ends of a horizontal boom. The antennas are separated by less than a half-wavelength (See Photo 3 above.) The antennas are switched back and forth electronically several hundred times per second. Two types of homing RDF sets operate on different principles, but they are used the same way.

Switched pattern units, such as the L-Per made by L-Tronics, use AM receivers and determine which of two antenna patterns produces a stronger signal.

Time difference of arrival (TDOA) units, such as the SuperDF made by BMG Electronics, work only with FM receivers. They use phase techniques to determine which of two antennas is closer to the signal source.

With both units, an indicator, such as a zero-center meter or a pair of light-emitting diodes (LEDs), tells the user which way to turn the antenna, left or right. A sharp "crossover" indication reveals when the antenna is pointed ex-



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actly at the signal source.

For switched pattern units, crossover occurs when signals reach equal amplitude as received by each pattern. For TDOA units, crossover occurs when the antennas are equidistant from the source.

Both types are sold commercially at reasonable prices. The L-Per comes with a built-in, four-channel, crystal-

controlled receiver; an attenuator; and a meter. It is compact and comes ready to use, but you must have a crystal for the desired frequency. Frequencies can be selected in one of several bands from 120MHz to 320MHz. Prices start at about \$400.

The SuperDF connects to an FM receiver or scanner, so it works over a wide frequency range: 100MHz to 260MHz on the VHF antenna and 250MHz to 550MHz on the UHF antenna. It does not need any additional crystals.

The SuperDF can be carried on foot, together with a hand-held receiver. Alternatively, its rotatable antenna can be mounted on a vehicle for use with a mobile receiver. The assembled SuperDF unit with VHF antenna is less than \$300, not including a receiver.

The portability of homing RDF sets is advantageous. They are easy to set up and carry. When not in use, they can be folded up and stored in a small space in the vehicle.

Despite a lack of antenna gain, they have enough sensitivity.

Both are highly accurate in the absence of multipath. Inferior stationary multipath performance is the major disadvantage shared by these units. It is best to stay in motion to "average out" the bearing swings caused by signal reflections.

Homing RDF units sometimes give unreliable results when the signal is horizontally polarized. Special techniques must be used in such situations.

S-meters are not needed with homing RDF units, which are not swamped by strong signals. Usually, these characteristics are advantageous. But sometimes they turn into disadvantages. Because the units do not display amplitude information, the hunter may pass by the subject transmitter without noticing it. With the L-Per, overshooting the transmitter is less likely because its internal sensitivity control indicates proximity to the transmitter.

Airborne RDF

If aircraft are used in your operations, do not overlook the advantages of airborne RDF. Besides the ability to cover large areas rapidly without traffic or road problems, the use of a high platform eliminates most multipath problems that plague ground-level VHF RDF in uneven terrain. Airborne RDF really shines in search and rescue operations in rugged wilderness.

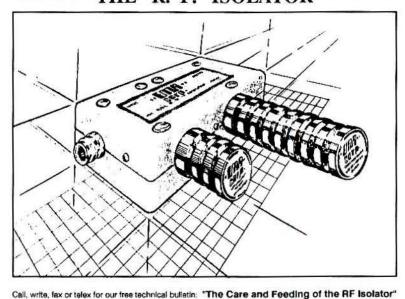
Homing RDF units, such as the L-Per or SuperDF, are ideal for airborne use because they indicate the direction to turn. Antennas can be mounted on the side of the cockpit or, less desirably, taped to the windshield.

Rotating antennas are unnecessary;



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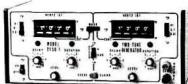
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just turn the plane! The pilot simply follows the RDF's left-right indications to fly right over the signal source. With practice, it is possible to maneuver a small plane to fly over the target with an accuracy of a few feet. Airborne RDF experts can determine from the air which car in a parking lot has the transmitter in it.

Ring antenna RDF sets

Just as there are two major types of homing RDF units, there are two types of ring antenna systems: Doppler and Adcock (sometimes called Watson-Watt). They use similar antennas and displays, but different processing techniques. One uses AM detection, the other, FM.

Ring antenna RDF units offer a major improvement in operating convenience compared to manually turned antennas. They are much easier to use, especially when hunting alone.

Ring antenna RDFs typically use a set of four or more identical vertical antennas. Dipoles are used for fixed installations. Quarterwave whips suffice for mobile use.

The mobile antenna system may be a single assembly fitted with suction cups to grip the vehicle roof, or four individual whips connected to a switcher

Direction-finding applications

- □ Recovering stolen radios
- ☐ Finding 'stuck mics'
- □ Tracking surveillance transmitters
- Search and rescue
- ☐ Tracing intermod sources

by coaxial cable lines of equal length. Individual magnetic-mount whips work fine. Either the suction-cup or magnetic-mount version is readily moved from one vehicle to another.

RDFs are popular for use with marine

VHF transceivers. Several companies make them, including Apelco, Koden and Simrad. Usually they are sold as add-ons for your own FM receiver, with no internal modifications necessary.

For the land-based two-way radio commercial market, Doppler Systems offers RDF sets with display and antenna for VHF highband beginning in the \$800 price class, not including the receiver.

RDFs using the Adcock principle require AM detection in the receiver. Often, the receiver is sold in a package with the RDF set, but an external receiver can be used, with minor modifications. Compudyne EWI Division supplies three-channel Adcock RDF sets under the name OAR for commercial use.

Both types of ring antenna RDF sets can be provided with a digital readout of bearing in degrees, or a less expensive circular display that "points" to the signal source direction. Doppler units typically use a ring of light-emitting diodes (LEDs). Adcock units generally



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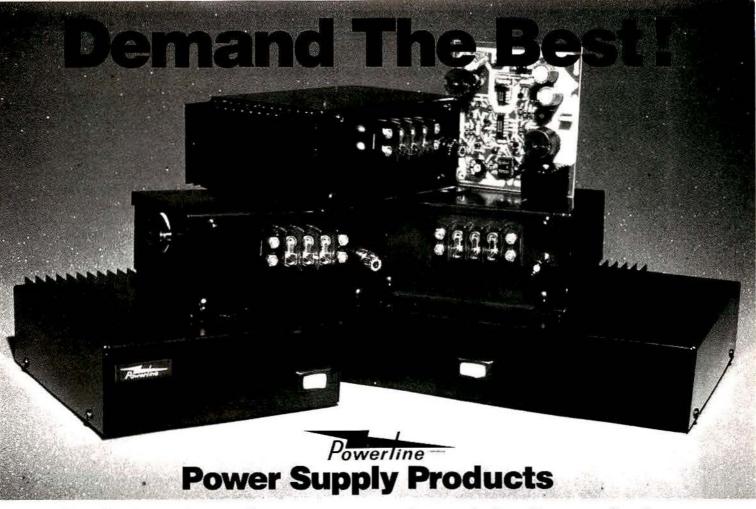
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Eastern Canada 1-416-937-3461 feature a cathode-ray tube (CRT) display with "vectors" pointing in the direction of signal sources.

The CRT display is superior because it clearly indicates the presence of most types of multipath. Be prepared to pay a premium for the CRT display: Adcock RDF sets generally cost several times the price of Doppler units.

Doppler and Adcock RDF units are

favorites of many RDF technicians because of their rapid response. No mechanical turning is necessary, so the units display bearings even for short signal bursts. Compared to yagis and quads, Doppler and Adcock units are more broadband and are easier to install on almost any vehicle.

Some inexpensive Doppler units use PIN diodes to "hard-switch" among the antennas. In areas with high RF levels, hard switching creates noise and cross-modulation products that reduce RDF sensitivity. Doppler Systems units use sophisticated "soft-switching" antenna selection circuits that minimize cross-modulation products and maximize sensitivity.

Ring antennas are not the answer for every RDF situation. They are not suitable for hand-carrying. They cannot be used to track pulsed or non-carrier signals, such as power line interference and single-sideband signals. Readout

Ring antennas are not the answer to every RDF situation.

resolution on some models is limited. Bearing error may be severe when the signal is horizontally polarized and when multipath is present. Sensitivity may be inadequate on weak signals.

Triangulation

Having read this far, you probably are convinced that equipping one of your vehicles with RDF gear could be important.

If your service area is small, one RDF vehicle might be all you need. But what if you service a large metropolitan system with satellite voting receivers, or a wide-area system with mountaintop repeaters? Your single vehicle is not likely to be in the right place at the right time to hear the source of the problem and respond rapidly.

When it is necessary to augment the single vehicle with additional RDF capability, it may be done by equipping more vehicles with RDF gear or by supplementing the mobile RDF unit with fixed RDF sites at strategic, elevated sites. Properly located base stations and vehicles can "triangulate" their bearings to reduce the search area dramatically.

Triangulation does not provide pinpoint accuracy. Bearing errors on VHF signals from elevated RDF sites can be



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DB561/4 directionals (806-952 MHz) provide 11 to 14 dB gain, 120° to 170° coverage and optional downtilt.

Omni Aeroglas ** DB553, DB557, DB559 (pictured) and DB560 offer 3-10 dBd gain. DB559 and DB560 offer 3°, 6° or 10° electrical downtilt.

New DB809-X/-Z omni MTD antennas handle 400 watts of power with 9 dB gain and up to 110 MHz bandwidth. The DB806-X/-Z has 6 dB gain.

DB737X elevated-feed trunk-edge mount and DB726 Teardrop™ mobile antennas provide 3 dB and unity gain.

The DB860 MTD antenna, with optional downtilt, offers 10 dBd gain and withstands severe environments.

Space-saving DB806TL (800-900 MHz)
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DB499 Yagi has 10 dB gain with 20 dB front-to-back ratio for control stations.

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New multiple antennas, with up to 100 MHz bandwidth, in one fiberglass radome are available for 806-960 MHz. For example, two DB806TL triple antennas are recommended for ten channel, 12.5 KHz spaced 900 MHz systems.

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High Quality Mobile Antennas

Extensive field tests have been made by Decibel on our own test range in Dallas. Results show that in general . . .

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DB8900 Tower Top Rx Amplifiers use DB4192 (800 MHz) or DB4196 (900 MHz) interdigital filter, below.





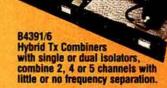
DB8500 Rx Multicouplers, with 800 or 900 MHz filters, expand to 32 channels.



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Factory Authorized Warehouses: Talley Electronics Co., Hayward CA, Santa Fe Springs CA and Phoenix AZ; CW Electronics, Denver CO; The Antenna Farm, Overland Park KS; M. Hutton Co., Dallas TX; ComMar, Inc., Westport MA; Tessco, Inc., Hunt Valley MD and Sparks NV; Primus Electronics Corp., Joliet IL; Cartwright Communications Co., Cincinnati OH. International: Marketronics, Sunrise FL (for South America Lenbrook Industries, Ltd., (Canada) St. Leonards, Quebec; Calgary, Alberta, and Pickering, Ontario, RAC, (Italy) Milan; Walmore Electronics, Ltd., (England) London; OmniTronics Enterprises PTE Ltd., (Singapore), Sistemas Profesionales S.A., (Mexico), Mexico City; R.F. Devices Pty., (NSW Australia) Miller.

Direction-finding equipment

- Beam antennas—yagis and quads
- Switched-pattern homing sets
- Time difference of arrival homing sets
- Doppler-shift ring antenna sets
- Adcock ring antenna sets

significant, depending upon the equipment used and the local conditions.

For example, atmospheric inversions and the "coastal effect" in the Los Angeles basin cause VHF hilltop bearings over land and water paths to appear to drift 15° or more in a typical day.

With three RDF sets accurate to a bearing resolution of ±10° and separated equally from one another by 20 miles, bearings to a transmitter midway between them would define an area of 13.8 square miles. Thus, hilltop sites alone are not enough for a complete RDF system, but they provide a target area for RDF vehicles.

Get started now

Whatever RDF system you decide is best for your particular needs, now is the time to obtain it and learn to use it. Do not delay. When you have need for RDF, it will be too late.

No matter how simple your chosen

system seems to be, it will take some time to become familiar with its use. Terrain affects readings, so you should make trial runs to track down transmitters in known locations.

Once you are comfortable with the system operation, have someone transmit to you from an unknown location to test your RDF skills. Once you have had a few successful hunts, you will be ready when the need to track a signal to its source arises.

RDF as a sport can be lots of fun. Amateur radio operators have held RDF contests since the earliest days of radio, using new technologies as they evolve. If amateurs in your area hold weekend RDF contests (often called "T-hunts" or "foxhunts"), they may have RDF experience that can help you or your agency in setting up your RDF capability.

RDF is not usually a daily activity, but when the need arises, it may be urgent. Take time now to become familiar with RDF. When the unknown carrier comes on, will you be ready?





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Radio direction-finders from \$125 to \$350,000

From home-grown beam antennas to sophisticated military-grade equipment, radio direction-finding equipment spans a wide range of sophistication, utility and price.

By Don Bishop Editorial Director

How often you trace interference sources makes a difference in what radio direction-finding (RDF) equipment you choose.

Occasional users keep costs low. Some make their own beam antennas. Some use antennas on hand. Others use inexpensive homing radio direction-finding (RDF) units in the \$100 to \$300 range. For \$500 to \$1,500, you can buy automatic RDF units with digital and compass displays. Other commercial and military units cost as much as \$350,000.

• Greenville, SC—Nathan J. Batson, a technician with Communication Service Center, uses a spectrum analyzer and "a directional antenna we made, though it would be nice to have a direction-finder."

After closing in on the source of interference, he uses a service analyzer and an attenuator pad with a service analyzer to pinpoint the source.

• Panama City, FL—John L. Beach, a technician with Southern Communication and Electronics, said his shop has conducted direction-finding only three times in six years. A yagi antenna mounted above the shop takes an initial bearing. Then additional bearings are taken using yagi antennas transported in vehicles. A service monitor with a spectrum analyzer serves as the receiver.

"On the first occasion, we found the interference came from a stolen or lost portable that some boys were playing with," Beach said. "The second eluded us entirely. The third was a legitimate radio user who wasn't giving the required identification."

• Memphis—Richard Beckum, a technician with General Communications, said unlicensed users have led to the use of direction-finding more than interference caused by intermodulation products. "A lot of dealers will sell to anyone who has money" regardless of whether the customer is licensed, he said.

When a General Communications customer reports an unauthorized user, "it reverts to us to find the source," Beckum said.

• Wichita Falls, TX—Roy E. Batty Jr., a technician who retired from Communications Service, said he used a Motorola Motrac and a six-element yagi to track interference on RCC channel 5. "I read the limiter with a test set to tell

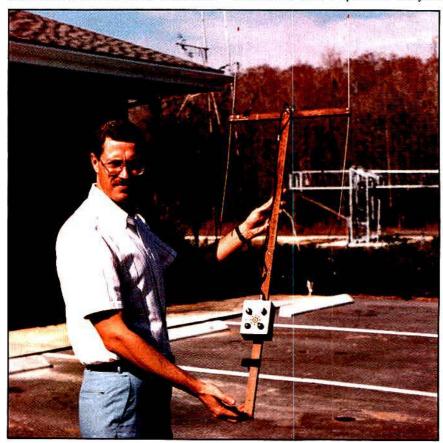
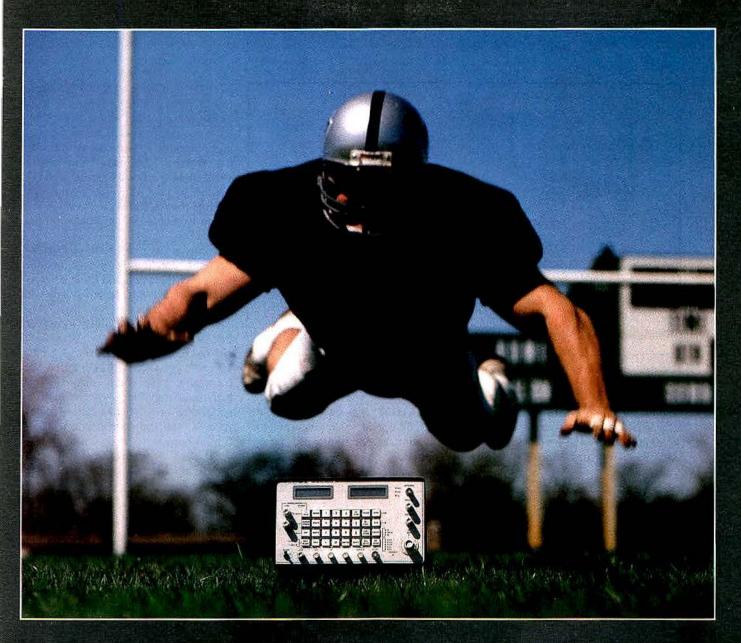


Photo 1. Robert C. McKinney, engineer-in-charge at the FCC Vero Beach, FL, monitoring station, holds the L-Tronics Little L-Per homing RDF used to trace signals on marine frequencies.



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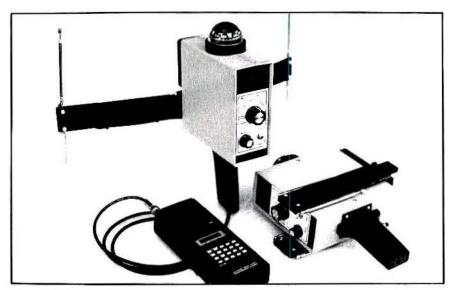


Photo 2. The Radio Engineers homing RDF uses any FM receiver. An audible tone indicates whether the target is to the left or to the right.

relative signal strength," he said.

Batty traced the interference to a tower 40 miles away. The source was a paging base station with spurious emissions.

· Kingsville, TX-Engineers at the FCC field operations bureau monitoring station at Kingsville use various equipment.

Brad Gilliland sometimes uses a hom-

ing RDF unit made by BMG Engineering. (A picture of the BMG unit appears as Photo 3 in another article on page 24. RDF equipment manufacturers are listed on page 46.) "The unit works with any receiver," he said. "You hold a small antenna and walk around with it."

Other homing RDF units are made by L-Tronics and Radio Engineers. (See Photo 1 on page 34 and Photo 2 at the

Common targets for RDF include unlicensed operation, spurious emissions that affect reception and cable TV system signal leakage. Another target is noisy power lines.

Gilliland advises, "Make sure your own house is clean.'

He told of one user in Corpus Christi, TX, who persisted with an interference complaint: "He would call and raise hell; somebody illegal was on his frequency." No new stations showed in our records, and the coordinator had approved no new radio operation.

"I drove all around Corpus Christi and did not hear the signal. The closer



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I got to his shop, I began receiving the signal. Everything indicated the building used by the complainant. 'No, it is not us,' he told me.

"Raise your garage doors," Gilliland said he told the complainant, who then raised the doors.

"Go over to your breaker box," Gilliland said.

The complainant did.

"Turn the breakers off one by one." When the third breaker was switched off, the interference disappeared.

The complainant said, "But we checked the radio out. We knew it wasn't us."

It was.

Gilliland described another type of situation: "Every now and then somebody calls about interference to their ra-

dio and they have no license, or they are on a frequency not covered by their license. No license, no protection. It is amazing that they have the nerve to call."

One of the individuals responsible for equipping FCC field engineers is W.L. Kilpatrick, chief of the bureau's equipment construction and installation branch in Powder Springs, GA. Kilpatrick said the FCC makes two direc-

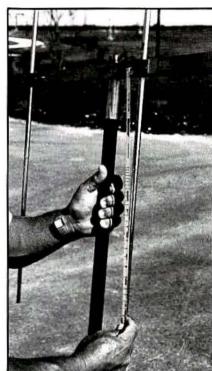


Photo 3. A tape measure is used to adjust elements on a yagi fitted with telescoping whips. The yagi is used for close-in RDF after the mobile RDF unit has pinpointed the building that houses the target.

One is a yagi with adjustable element lengths and spacings. The hand-carried vagi uses as many as three sets of ele-

ments. It covers 50MHz to 300MHz.

Barry Nadler at the Vero Beach, FL, FCC monitoring station, using a tape measure to adjust the yagi elements. Reflector and director elements slide to-

ward or away from the driven element.

The boom is marked with a frequency

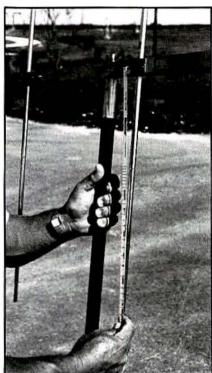
Photo 3, above, shows senior engineer

direction-finding activity.

scale for proper spacing.

FCC construction facility

tional antennas for its portable



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Nadler uses a tape measure calibrated to radio frequencies to adjust the element lengths. Photo 4, at the right, shows Nadler holding the assembled antenna. In the background is a tilt-over tower that holds a commercial UHF logperiodic antenna used for fixed RDF. A close-up of the antenna appears in Photo 5 on page 42.

The FCC makes a portable, broad-

band, cavity-backed spiral antenna for RDF at UHF above 300MHz. It consists of exponential spiral coils that, by the nature of their circular, exponentially expanding characteristic, have a broadband frequency response. To obtain a unidirectional pattern, the coils are mounted in a box to shield reception from the rear.

"We make these antennas because it

is economically feasible for us to do it," Kilpatrick said. "If it is possible to buy commercial, we do. We provide direction-finding equipment for any purpose the FOB finds is necessary."

Nadler sometimes traces intermed product sources in congested areas. Local service technicians can learn how to find them, too, he said.

First, bearings are taken from fixed locations, when possible. To triangulate

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Photo 4. Senior engineer Barry Nadler at the Vero Beach, FL, FCC monitoring station, holds an assembled VHF yagi antenna with adjustable elements.

the source, Nadler sometimes calls upon two-way radio shops with rotatable beam antennas to take a second bearing.

Then an FCC mobile RDF unit goes to the triangulated area to narrow the source down to a building.

FCC's mobile direction-finder

The FCC designs and builds its own mobile automatic direction-finder (MADF) systems. FCC officials do not want photographs taken of the agency's MADF-equipped vehicles. Similar equipment is available from Tech Comm, a company that has licensed the FCC patent. (See Photo 6 on page 44.)

The FCC's Kilpatrick described part



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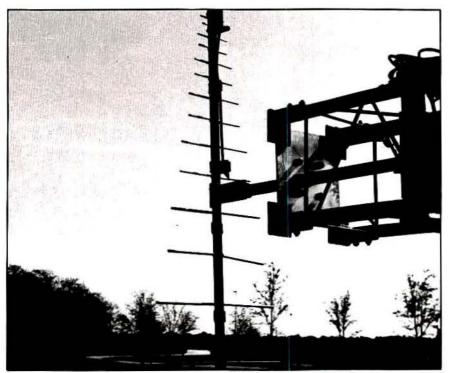


Photo 5. The FCC Vero Beach monitoring station uses this UHF log periodic antenna, shown in resting position on a tilt-over tower, to take RDF bearings.

of the system: "For its antenna, the system uses a cavity-backed annular slot receptor on a conductive surface. The slot has inductive reactance that, when added to the capacitive reactance of the top-loaded center receptor, creates a reasonable impedance match over a wide frequency range." The FCC antenna design includes two concentric cavity-backed annular slot circles to enable a response from 500kHz to 1.000MHz.

In many FCC mobile RDF units, the antenna is recessed into the vehicle roof and covered to conceal it.

Photo 7 on page 45 shows an unconcealed antenna mounted atop a van. Photo 8 on page 48 shows the processor and bearing indicator mounted on a dashboard.

"The display used by the FCC indicates in ±3° steps," Kilpatrick said. "The bearing resolution depends on the car heading. The four quadrature points at 0°, 90°, 180° and 270° are the most accurate with ±5° accuracy; the 45° points give about ±10° accuracy; and

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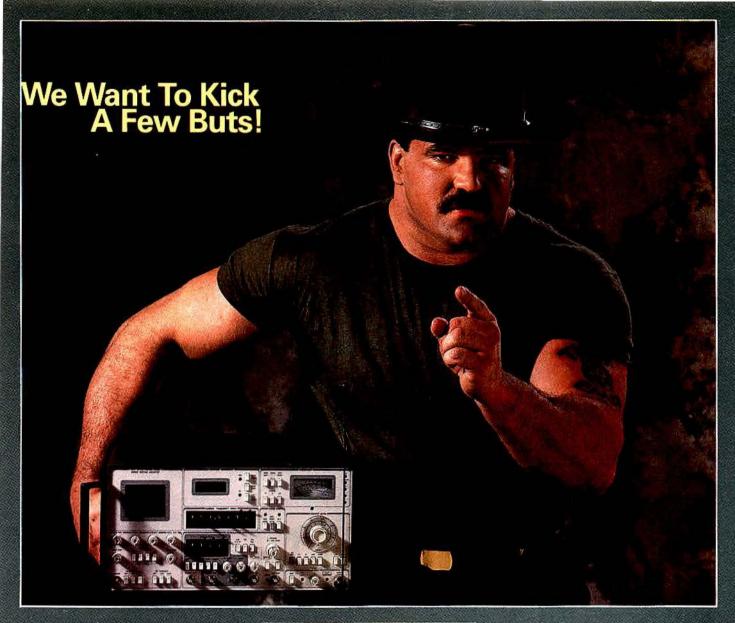
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Photo 6. Equipment similar to the FCC's mobile automatic direction-finder (MADF) is available from Tech Comm, a company that has licensed the FCC patent.

the 22.5° points yield ±15° accuracy."

According to Tech Comm president John A. Stangle, prices for MADF equipment range from \$20,000 to more than \$100,000, depending upon the specific configuration and receiver complements.

Hand-held antenna

After tracing the signal to a building by using the mobile direction-finder, FCC engineer Nadler uses a service monitor and a hand-held antenna to pinpoint the source. "We use an attenuator in the line and keep adding attenuation as we home in on the signal."

The service monitor has a spectrum analyzer that tells something about the signal, as well as giving a graphic display that can be used instead of an audible signal for strength indication. "The spectrum analyzer is useful in high-noise areas," Nadler said.

Monitoring stations are equipped with decoders for digitally encoded squelch signals and tone-coded squelch signals. (See Photo 9 on page 48.) "Each sta-

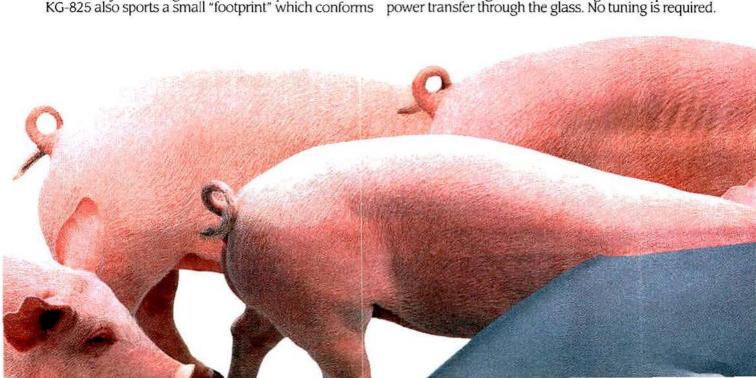
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tion has its own encoding that becomes a 'fingerprint.' Local land mobile dealers generally have lists of tones being used. We use their lists for information about stations," he said.

"Many interference cases are resolved by telephone, using information from our files, licensing information and offthe-air monitoring." Nadler used the "stuck mic" example. The licensee often can be identified through records, the tone-coded squelch frequency or through service representatives with lists of customers on the frequency in question.

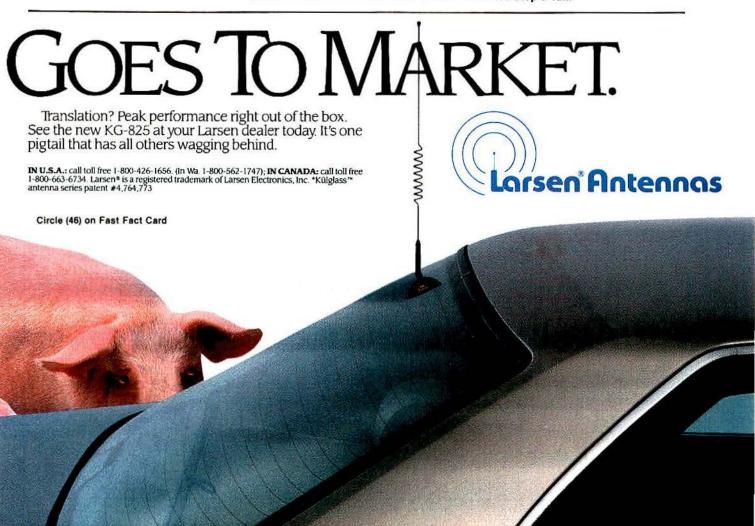
"Those that require direction-finding are those where we have undetermined locations for transmitters. Occasionally we get a mobile unit mic that gets stuck."

Nadler said sometimes licensees call for help with their own systems. Sometimes the causes are found to be disgruntled current or former employees.

Another tool at the Vero Beach station is the L-Tronics Little L-Per crystalcontrolled RDF unit. "We use it strict-



Photo 7. An unconcealed MADF antenna mounted atop a van.



Radio direction-finders

Time difference of arrival homing devices

- ☐ BMG Engineering (SuperDF) Circle (301) on Fast Fact Card
- ☐ Radio Engineers (Vectorfinder) Circle (302) on Fast Fact Card

Doppler-shift devices

□ Doppler Systems Circle (303) on Fast Fact Card

Marine devices

- ☐ Apelco (AXL 1550 ADF) Circle (304) on Fast Fact Card
- ☐ Koden (KS-538 ADF) Circle (305) on Fast Fact Card

Switched antenna homing devices

☐ L-Tronics (Little L-Per) Circle (300) on Fast Fact Card

Watson-Watt devices

☐ Compudyne EWI Division (OAR) Circle (306) on Fast Fact Card

Adcock and 'Flat' devices

☐ Simrad (Talyo) Circle (307) on Fast Fact Card

Non-disruptive phaseamplitude devices

☐ Tech Comm (mobile ADF) Circle (308) on Fast Fact Card ly for marine frequencies, including channel 16, channel 6 and 121.5MHz, the frequency used for marine and aviation distress," Nadler said. In Photo 1 on page 34, Vero Beach monitoring station engineer-in-charge, Robert C. McKinney, holds a Little L-Per.

Doppler-shift

One direction-finding system for fixed or mobile use is based on the Dopplershift principle. Dave Cunningham, president of Doppler Systems, Phoenix, AZ, explained the technology:

"Outputs from four antennas are summed electronically in a way that simulates an omnidirectional antenna rotating in a circle in the horizontal plane at a rate of 300 times per second. As the simulated antenna swings in a direction approaching the received signal's wavefront, there is an apparent increase in frequency. As it swings away from the transmitter, there is an apparent decrease in frequency.

Cunningham said that the output of the "rotating" antenna induces a 300Hz

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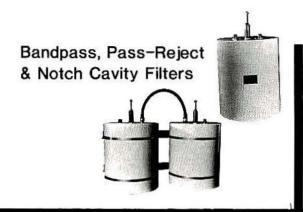
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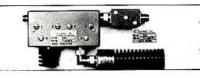
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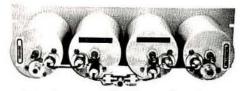


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Circle (48) on Fast Fact Card



Photo 8. The MADF processor and bearing indicator mounted on a dashboard.



Photo 9. A portion of the monitoring position at the FCC's Vero Beach facility includes VHF and UHF receivers with digital and tone decoders.

tone in the output of a narrowband FM receiver. The direction-finder processes the audio information to determine the bearing of the transmitter.

"Antenna spacing is not critical but should be maintained at 1/8-wavelength to 3/8-wavelength," Cunningham said. "The antennas should be mounted in the clear, away from other antennas or metal elements, or dense growths of trees." Photo 10 on page 50 shows a unit with digital and LED compass displays. Options include RS-232 output for computer processing and a speech synthesizer for "eyes on the road" driving. Photo 11 on page 50 shows a mast-mounted antenna for 700MHz to 1,000MHz use. Antennas for other frequency bands and for mobile use are available from the manufacturer. Alternatively, antennas



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Radio Intelligence Communications (RICS) of Nashua, NH, uses a Dopplershift direction-finder to locate interference sources and listening devices ("bugs"). Photo 12 on page 52 shows the company's mobile installation withmagnetic-mount antennas positioned on a car roof.

RICS uses the customized fixed antenna shown in Photo 13 on page 52.



Photo 10. A Doppler Systems RDF processor with digital and LED compass displays.

Five antennas rest on a rooftop platform made from steel angle. The fifth antenna, in the center, is for omnidirectional reception. The configuration of the steel-angle platform allows the antenna spacing to be adjusted for frequency. The purpose of the platform antenna installation is to measure a signal's initial bearing and strength.

RICS' antennas are made with stainless-steel telescoping whips so their lengths may be adjusted for frequency. The whips are spliced with 8-gauge copper wire to fit the center conductor of a PL-259 connector. The connection is potted with silicone rubber to provide support and insulation.

The Doppler-shift RDF equipment costs about \$500 to \$1,000

Watson-Watt

Another type of direction-finder uses the Watson-Watt technique, a British principle developed in the 1920s and updated with modern technology. The original technique employed three matched receivers. Three separate an-



Photo 11. A Doppler Systems mast-mounted antenna for 700MHz to 1,000MHz use.

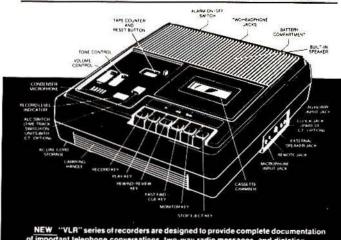
tennas composed the antenna array, one phased for a north-south bidirectional pattern, one for an east-west pattern. one for an omnidirectional pattern. The receivers processed each of the three antenna array outputs.

Modern technology has led to a single-channel Watson-Watt system that uses one receiver, reducing the cost and making the system more compact.

"The processor compares the magni-









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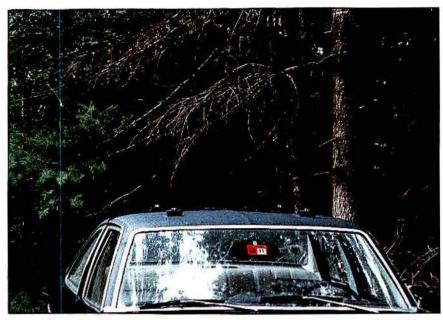


Photo 12. A vehicle equipped with four magnetic-mount antennas for mobile RDF with a Doppler Systems unit.

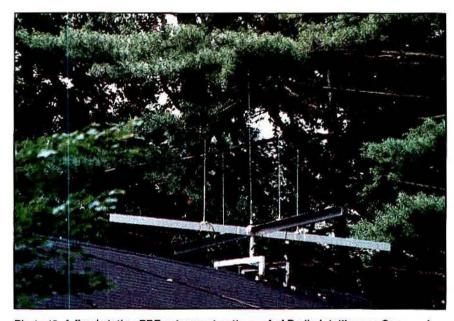


Photo 13. A fixed station RDF antenna atop the roof of Radio Intelligence Communications, Nashua, NH. Ideally, the antenna should be positioned away from trees.

tude of signals received by the bidirectional array, computes the gross phase angle between the two signal voltages and infers the relative azimuth of the transmitter," according to Rod Botsai, principle design engineer with Compudyne EWI Division. "The system can use either the receiver's IF output or the receiver's AM audio output." The unit generally exhibited at land mobile trade shows has a CRT bearing display.

Sold under the name OAR, the

Watson-Watt units made by Compudyne sell for \$10,000 to \$15,000.

Marine direction-finders

Boats often are equipped with automatic radio direction-finders for navigation. Comparatively high marine direction-finder sales cuts the cost. But marine and land mobile users have only one band in common—VHF highband. As long as all your direction-finding is at 150MHz, marine units may serve

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your purpose.

Many of the units, including those made by Koden and Apelco, use Adcock RDF antennas. (See Photos 14 and 15 below right.) Bob Holley, the service manager for Apelco, said the processor scans the Adcock array's four vertical elements in north-south and east-west pairs, comparing the phase angles of the signal received by each element pair.

The phase angle from the north-south pair develops an error voltage that represents a vector component. The phase angle from the east-west element pair develops an error voltage that represents a second vector component.

The combined error voltages yield a bearing toward the received signal with an accuracy of $\pm 3^{\circ}$ to $\pm 5^{\circ}$.

Apelco units sell for about \$1,000.

Koden units cost about \$6,000.

Simrad markets Taiyo land mobile and marine direction-finders that use either an Adcock antenna or a flat antenna that can be mounted for mobile use or carried for portable use. Units cover

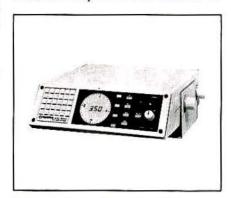


Photo 14. An Apelco marine RDF processor and display unit.



Photo 15. A Koden marine RDF processor and display unit.

frequency bands from 30kHz to 1,000MHz. Prices range from \$2,000 to \$350,000.

Plenty of choices

Hardly any aspect of radio communications technology has such diverse techniques and equipment choices as radio direction-finding. Beam antennas and simple homing devices anchor the low-cost end of the scale. Broadband slotted antennas and sophisticated signal processors inhabit the other end.

With careful selection and practice using your RDF equipment, you will be ready to respond quickly to urgent interference problems that require transmitter hunting.











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APCO wrap-up/review

Frequency coordination fees come down for system operators who reduce interference. Exhibit difficulties prompt the association's president to appoint a task force to come to grips with vendor concerns.

MRT Staff Report

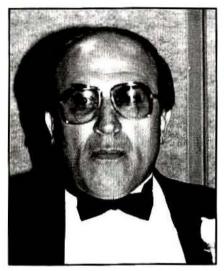
The Associated Public-Safety Communications Officers' (APCO) 55th annual conference brought an estimated 3,000 delegates to John Ascuaga's Nugget hotel in Sparks, NV, Aug. 6-11.

Conventioneers saw plenty of action:

- Elections—John S. Powell took a place on the board of officers as second vice president. Ronnie Rand advanced to first vice president; Sam Gargaro to president-elect; and George Murray was installed as APCO's president. Outgoing president Gary David Gray became a life member.
- Frequency coordination—Gargaro announced frequency coordination fee reductions that became effective Sept. 1. Coordinations for actions that do not increase the potential for interference now carry no fee. Examples include: a



APCO president George Murray set goals for improving spectrum management and making the APCO Institute grow.



APCO president-elect Sam Gargaro announced frequency coordination fee reductions for actions that reduce interference.

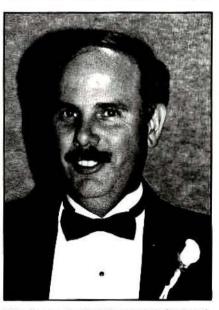
reduction in the number of mobile units; a transmitter power output reduction; an effective radiated power reduction; and an antenna height reduction.

Also qualifying for free coordination are interoperability on specified channels under the National Public Safety Planning Advisory Committee's (NPSPAC) national 800MHz plan and operation on the national law enforcement channel when the proposed operation is part of a state plan.

Frequency coordination manager Alireza Shahnami encouraged potential license applicants to call their local APCO frequency coordinators and "Ask for what you want." The precoordination effort is said to speed applications, once filed, through the formal processing. For the identity of the coordinator in your area, call 904-426-1510.

 Exhibitions—Within hours of the exhibit hall's opening on Tuesday, representatives of the conference sponsor, APCO's Northern California Chapter, told vendors they had made an extraordinary decision to cancel Thursday's exhibit hours.

Greyhound Exposition Services contracted to set up and tear down most of the exhibits. One exception, the Celwave booth, was assembled by independent contractors and required 11 hours to erect. Randall J. Friedberg, Celwave's manager of distributor sales, said it was a new booth being erected for the second time. Observers who saw the time required for the Celwave booth and other exhibits grew concerned that teardown might take so long that the ballroom could not be cleared Thursday between 11 a.m.-the scheduled exhibit closing-and 4 p.m.-the time set for the hotel to begin setting places for the banquet. The ballroom housing about half of the exhibits was to shelter a



Winning an election for second vice president, John S. Powell took a seat on the APCO board of officers for 1989-1990.

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THE "A" TEAM HAS ARRIVED! The new 2955A and 2957A radio comms test sets.

From the company that developed the world's most popular radio communications test set comes the 2955A. It looks the same. It costs the same. It operates the same, but inside are new features:

- Digital Coded Squelch encode and decode
- DTMF encode and decode
- POCSAG pager testing, including alphanumeric
- Up to 33 tone sequences
- Waveform generator with Sine, Square, Sawtooth and Triangle waveforms
- Auto routines for Rx sensitivity and B/W measurements
- Off-set level adjustment for test "cradles" or cables, couplers in the RF output
- +5dBm Signal Generator output level
- And more...

The two enhanced, independent, audio generators, along with digital modulation capability, make this test set a real powerhouse when evaluating FSK NRZ digital tone systems.

For the testing needs of the cellular industry, the 2957A continues to offer the diagnostic power of an engineering work station while retaining user friendly, pushbutton operation for entry level technicians in the service shop.

Don't forget the most comprehensive CRT display available. Only the 2957A leaves no doubt about interrelated measurements. You view both the transmitter and receiver results simultaneously. 2957A improvements include:

- Revert to DC power supply
- Improvements in the bus structure with additional tests available.

For example, data and ST deviation measurements along with hook flash results and ST duration (timing) information, are included as standard test routines available to bus users.

What is the real bottom line? A proven cellular test set that continues to grow to meet the expanding needs of the industry.

For users who need to test cellular or trunking radios with protocols of an international structure, the new Model 2960 offers the ability to select from up to six internally installed standards that include:

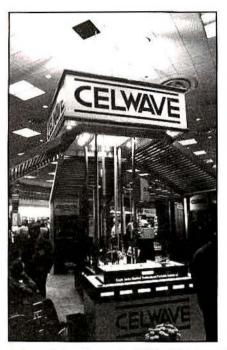
- AMPS, TACS, NMT, and RC2000 Cellular formats (variants also available).
- Band III Trunking protocol

For further details on the above products, or to join the Marconi Users Group (MUG), contact your local Marconi Representative or call direct (800) 233-2955; Fax: (201) 934-9229 or write: Marconi Instruments, Inc.

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Celwave's booth reached 15 feet high, meeting the terms of its waiver. Antennas extended above the suspended ceiling. But the Phillips-E.F. Johnson booth exceeded its height limit. Phillips' Joseph Gallelli said: 'It won't happen again.' APCO's Bob Buttgen said booth drawings and plans would be required of next year's exhibitors.

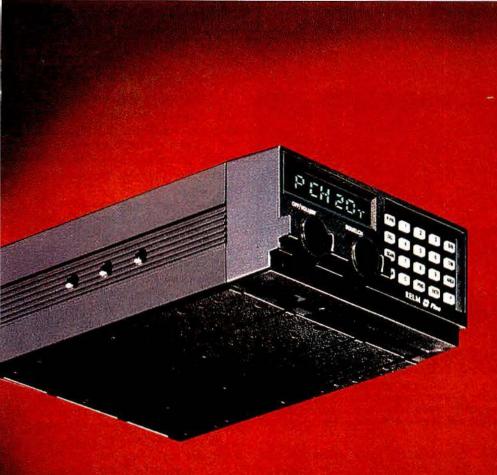
reception and banquet beginning at 7 p.m. Thursday. Greyhound national sales manager Claudia Pierce disclosed several factors that caused the sponsor to reconsider Thursday's exhibit hours.

"Banquet ticket sales rose from the 1988 total of 1,000 to 1,600; this year's exhibits are more elaborate than last year's; and unusual rainy weather forced crates to be stored in trailers where access to them is slowed." Pierce said: "We could do it [clear the ballroom for the banquet], but there would be a lot of panic, missing freight and displays would have to be shoved over [to space adjacent to the ballroom] without being torn down."

Conference chairman A.A. "Scoop" Sairanen said the commercial advisory committee chairman, Larry Kline, was consulted. Kline polled about 10 vendors and decided not to oppose the cancellation of Thursday's exhibit hours. "What would you do if you had to choose between vendors having two hours of exhibit time on Thursday morning and APCO having its evening ban-

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ery High Performance and Very ligh Quality in a VHF system. hat's what you want...that's what ou get with VHFPQ Radio from ELM Communications.

Advanced Features

oth the new RMV60B mobile and ne revolutionary RSP500 portable hare the same advanced technology and features.

Continuous Track Tuning allows for access to the full 148-174 MHz bandwidth with virtually no degradation.

Both offer built-in Digital Coded Squelch (DCS)* as well as CTCSS.

They feature RELM Communications' Instant Priority^{IM} button. Just one touch of the Instant Priority^{IM} button puts either radio in its highest priority channel at the highest power level available.

- Fast Scan technology allows both radios to scan their channels at a rate of up to 40 channels per second.
- Both are synthesized and ruggedly built using SMD technology and aluminum chassis' to better withstand higher levels of shock and vibration.

The RMV60B has 1-45 channels which can be programmed into four separate scan areas with a priority channel for each area. The RSP 500 has 20 channel capability and a reversible display.

When you need a VHF system that has power, quality and compatibility... look for VHFPQ Radio, from RELM Communications!



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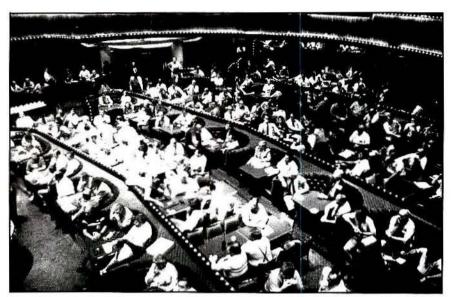




The RSP500 features a unique alpha-numeric reversing display so you will always be able to read it right side up no matter how it is being used. In normal operation, the RSP500 reads from the front. When belt mounted with the optional remote speaker/mic, the display reverses itself so even though the radio is facing away from you, the display is still readable.



DCS is compatible with DPT of a trademark of Motorola, Inc.



The APCO membership quorum rejected the commercial advisory committee's plan for electing its own chairman. Later, APCO president George Murray rejected the committee's choice for its chairman and appointed Bill Plant of the Communications Group, Woodstock, NY. The committee had chosen Bob Vincent of Syntonic, Harrisburg, VA.

quet?" he asked. Some vendors said they would rather have forced the banquet to be canceled, in view of expenditures for lodging and airfare that could not be rescheduled and booth hours they contracted for but could not use.

 Commercial advisory committee— Some exhibitors complained Celwave's booth was overheight. The height limit was 12 feet. Celwave had a waiver extending the limit to the top of its booth, 15 feet above the floor. (See photo on page 58.)

Celwave placed antennas above the 15-foot limit with the understanding that they would have to be removed if APCO complained. Two antennas extended above the ballroom's suspended ceiling.

Celwave's booth met its limitations. but another's did not. The Philips-E. F. Johnson booth extended 5 feet or more over the height limit. (See photo on page 58.) Joseph Gallelli, representing Philips, told the committee, "It won't happen again."

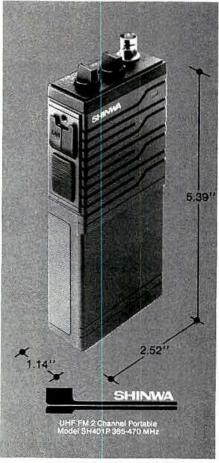
Reacting to the discussion, APCO convention manager Bob Buttgen said: "We're going to demand drawings and plans [for booths] for Boston [referring to next year's conference]." Midland International sales vice president Scott Henderson said: "A few people get to do whatever the hell they want to."

A great little radio

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The SH401P is a 2 channel UHF FM portable with a 1.5 watt minimum power output. Frequency coverage is 385-470 MHz. All units are shipped with one set of crystals installed.

Many available options include: tone pad. CTCSS, two-tone decoder, belt clip, external speaker/microphone, earphone. leather holster and shoulder strap.



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And a Talkback pager

With the optional two-tone decoder board installed, the SH401P can be used either as a UHF portable or a talkback pager.



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Vendors' moods, already charged by the cancellation of Thursday's exhibit hours and the booth-height spat, were not improved when APCO president Murray rejected the commercial advisory committee's recommendation for its new chairman in favor of his own pick. Furthermore, a resolution initiated by the committee to amend APCO's constitution and bylaws to allow the committee to select its own chairman unanimously was defeated by the quorum of APCO members who voted.

Thus, instead of Bob Vincent, vice president of business development for Syntonic, Harrisburg, PA, the committee's pick, Murray chose Bill Plant, owner of The Communications Group. Woodstock, GA, as 1989-1990 commercial advisory committee chairman. "No committee chairman in APCO is selected by its committee," explained Murray. "The executive board and council recommended the resolution not be approved, for two reasons:

"One, it is a change in the traditional way APCO operates.

"Two, the group thought the president should have a say in chairmen.

"Bill Plant and I have known each other for a number of years," Murray said. "I know he has exceptional organizational skills."

Vincent disagrees: "The committee had a good rapport, and Bill Plant has not attended most of the meetings. He does not have a good feel for what the committee tries to accomplish. I think the other committee members feel betraved."

· Task force-To dissuade future exhibit rules violations, Murray formed a task force to oversee procedures. The 10-member task force reports through the commercial advisory committee. Some members serve on both committees.

"We have to enforce the booth height limitations," Murray said. One of the task force's responsibilities is to publish an exhibits manual.

"The task force can spend all its time on exhibits, freeing the commercial advisory committee to pursue other issues," Murray said.

The commercial advisory committee's agenda includes:

- (1) participation in the annual conference, including MANAPCO night, programs and displays.
- (2) participation in regional conferences.
- (3) conveying vendor opinion about spectrum management issues.
- (4) supporting and assisting the APCO Institute's educational activities.
- (5) assisting in the selection of sites for annual conventions.
- (6) examining other issues as assigned or self-generated.

Goals Murray set for his APCO presidency include improving spectrum management and making the APCO Institute grow. He advocates expanding the APCO Institute with more courses for supervisors and administrators, "Education will help APCO reach its goal of the recognition of public safety communications as a profession," he said.





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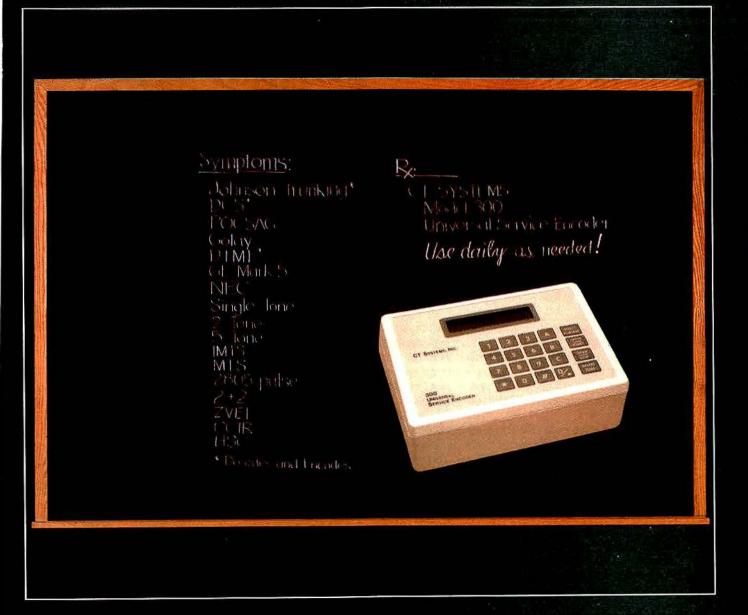
These antennas are designed for optimum system performance and reliability in the most severe environments. Each antenna is completely enclosed in a heavy fibreglass radome attached to a thick cast aluminum backplate. The radome's slick gelcoat finish resists ice buildup. All fastenings and hardware are of corrosion-resistant stainless steel. You can depend on Scala quality, proven in professional broadcast and communication systems around the World during the past 36 years.

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With all of this going for it, the CT Systems Model 300 Universal Service Encoder is nothing to sneeze at. And, at only \$895, you won't have to cough up a lot of money.

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Swersweep: A new method of measuring SWR

Swersweeping helps technicians to adjust RF systems faster and to a higher level of performance. Use a kit designed to work with a service monitor that includes a tracking generator and spectrum analyzer.

By Joe Peterzak

Quicker and more precise shop measurement methods help service organizations to compete, to maintain system equipment efficiently and to deliver customer satisfaction.

A standing wave ratio (SWR) measurement kit allows a technician to swersweep, that is, to sweep across a frequency range to make continuous SWR measurements that a video screen displays as a plot or graph. Swersweeping speeds cavity and filter tuning, as well as adjusting and maintaining system equipment, two-way radio antennas and cellular mobile telephone antennas.

Swersweep measurements offer special advantages with trunked two-way radio and cellular mobile telephone systems because they use broad frequency ranges. With conventional measuring techniques, a large number of individual measurements are required to produce a rough plot of SWR bandwidth. A swersweep measurement plots an entire band at once. Swersweeping helps the technician to upgrade and maintain modern systems to a new level of precision.

Test method comparison

 Wattmeter method—To correctly check and align newer systems, a technician must read SWR over a broad frequency range. Previously, the most practical method involved an analog wattmeter.

Performing the test requires highpower RF and a selection of wattmeter elements ("slugs") for different frequencies and power levels. To make readings, a technician twists the slug first one way, then the other, to measure forward and

reflected power. Then the technician uses a chart to convert power readings to SWR readings.

· Swersweep method-To align modern broadband two-way systems properly, a technician must read SWR directly, at a glance, over a broad frequency range. At the same time, the use of high-power RF signals that could overload and change the impedance of some devices must be avoided.

A swersweep SWR measurement kit works with a tracking generator and a spectrum analyzer like the kind found in modern service monitors, such as the IFR 1200S. The kit allows the monitor to display SWR vs. frequency on its cathode-ray tube (CRT) video display. High-power RF is not used. The kit can be used to swersweep antennas, filters, transmission lines, isolators and receiver front ends.

Sweep measurements

The test setup is shown in Figure 1 at the left. Connect the swersweep to the service monitor, and set the desired center frequency and span on the monitor. Disconnect the calibrated 50Ω from the device under test (DUT) for an infinite-SWR reading used for calibration.

Figure 2 on page 66 represents the CRT display of an infinite-SWR calibration line. Adjust the service monitor's vertical position control so the calibration line intersects with one of the screen's upper horizontal graticules.

That completes the test setup calibra-

0dB REFERENCE INPUT (TRACKER

Figure 1. Use this test setup to calibrate and test the swept-frequency measurement equipment. First take a calibration reading without the precision load, then a test reading with the precision load.

Peterzak developed and manufactures a swersweep SWR measurement kit. He owns Europa Marketing, Mesa, AZ; 602-345-6666.



SIMPLEX PATCH AVAILABLE



VCS-2100 VOX CONTROLLED SAMPLING INTERCONNECT

The Interconnect Specialists Inc. (ISI), VCS-2100, uses a combination of VOX control from telephone line audio, and sampling of receiver noise, to achieve the optimum control method for a simplex interconnect. No sampling interruptions occur during normal conversation. Turn-a-round beeps make operation very smooth and easy.

The VCS-2100 features the ISI exclusive, Automatic Setup. This feature eliminates the trial and error method of sample window setup. Our Quick Start Set-up procedure gets the VCS-2100 up and running, without complicated programming. The VCS-2100 is superior to any other interconnect in its price range. It is a plug-in replacement for the popular 510SA Smart Patch.

FEATURES:

AUTOMATIC SET-UP

Automatically sets the sample window for your transceiver. No more trial and error.

TURN-A-ROUND BEEPS

Sends beep to telephone line, and to mobile indicating it's their turn to talk.

USEŘ PROGRAMMABLE CW ID

CW ID can be programmed using DTMF. ID can be programmed to be sent at the beginning, the end, both, or not at all.

AUTOMATIC BUSY DISCONNECT

Automatically disconnects if the telephone number dialed is busy.

HOOK-FLASH

Used to make a second call without disconnecting and re-connecting. Also can be used for phone company services which use Hook-flash.



If a mobile call is attempted and the line is in use, a beep is sent to the phone line indicating that the mobile wants to make a call. Then when the line becomes available, a ring-out is transmitted to the mobile.

RING-OUT (REVERSE PATCH)

Can be programmed to ring-out one time, on each ring, or not at all, when the line rings.

SINGLE OR MULTI DIGIT CODES

Connect or disconnect codes can be single * and #, or * and # plus two digits.

CALL LIMIT TIMER

Can be set for 3, 4, or 5 minutes, or disabled. Can be programmed to reset with *.

MOBILE ACTIVITY TIMER

Causes disconnect if mobile drives out of range. Can be set to 30, 45, 60, or 90 seconds.

TOLL RESTRICT

The first digit dialed cannot be a "1" or a "0". Rearms after dialing is complete.

PHONE LINE IN USE INHIBIT

Prevents interrupting a call when the patch shares the telephone line with a telephone.

TOLL RESTRICT DEFEAT CODE

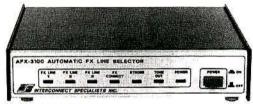
A special programmable code allows toll calls. Also allows access to line, even if line is in use.

TONE OR PULSE DIALING

Switch programmable for Tone or Pulse dialing. Pulse dialing can be used on a tone line.

HALF DUPLEX MODE

The VCS-2100 can be used as a repeater interconnect in this mode.



AFX-3100 AUTOMATIC FX TELEPHONE LINE SELECTOR

The AFX-3100 automatically routes mobile telephone calls to one of four trunk lines, as determined by the first three digits (exchange code) of the telephone number dialed. One local line and three FX lines can be accommodated. Up to 640 exchanges can be assigned to any of the three FX lines. A built-in keyboard is provided for programming of FX exchange numbers. Local line exchanges need not be programmed.

- HANDLES BOTH INCOMING AND OUTGOING CALLS
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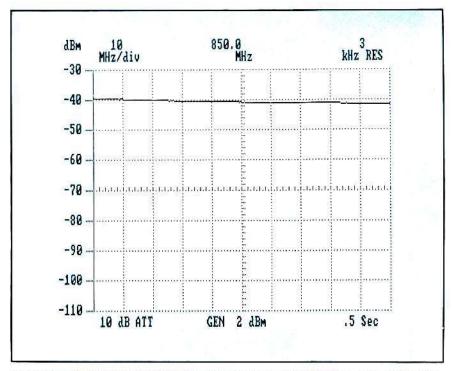


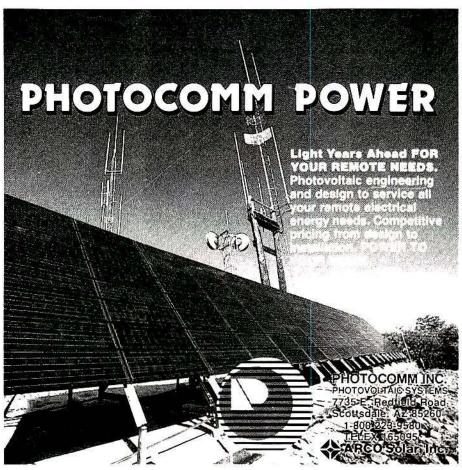
Figure 2. Adjust the CRT display so the infinite-SWR calibration line corresponds with an upper graticule. The reading is taken with nothing connected to the device under test (DUT) port, a condition that represents an infinite SWR vs. frequency.

tion. The setup is ready to plot SWR vs. frequency on the CRT display when a device to be tested is connected to the DUT port.

The load supplied with the coupler is precise, matched to the couple and calibrated to a standard issued by the National Institute of Standards and Technology (formerly National Bureau of Standards). When this load is connected to the DUT port, the screen trace drops, indicating an extremely low SWR over the frequency range. (See Figure 3 on page 67.)

With a device connected to the DUT port, the difference between the calibration trace and the measurement trace corresponds to the DUT's SWR. The lower the trace, the lower the SWR.

The difference between the calibration trace and the measurement trace is called return loss, which is another name for voltage standing wave ratio (VSWR). Return loss is the term more often used than SWR by engineers and manufacturers who design and make radio equipment. Engineers usually meas-



Circle #62 for a free Energy Systems Catalog, S5.95 value.



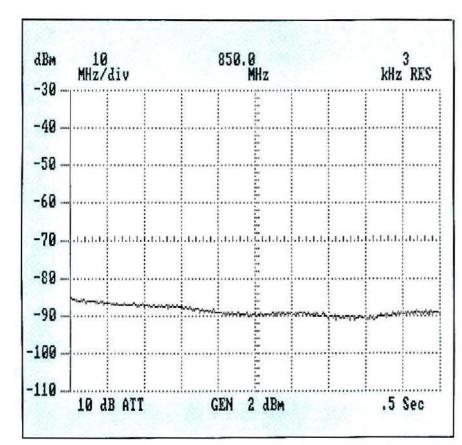


Figure 3. Terminate the DUT port with the precision load to test the SWR measurement function. The screen trace drops, indicating virtually the lowest possible SWR (-50dB return loss = 1.006:1 SWR). Each graticule represents -10dB return loss.

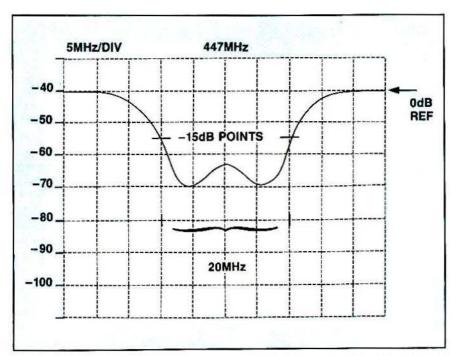


Figure 4. The CRT trace shows the swersweep of a Decibel Products DB420 broadband UHF base station antenna. Notice that its SWR is less than 1.5:1 from 450MHz to 470MHz, a 20MHz span.

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ure return loss with a network analyzer.

To convert return loss to SWR, refer to a graph or chart. Table 1 at the right shows common values.

For many purposes, a good SWR is defined as any value equal to or less than 1.5:1, which is equivalent to a return loss of -15dB. Service monitor screens generally are calibrated to represent 10dB between graticules. Thus, an SWR

of 1.5:1 and a return loss of -15dB is represented by a trace dropping to a level 11/2 graticules below the calibration

While adjusting a device to an optimum setting, the technician tunes it to modify its response over the frequency range so the return loss does not rise above -15dB at any operating frequency.

Swersweep precision may be demonstrated with the use of the calibrated load. The test shows the critical nature of RF connections at UHF.

Adjust and calibrate the test setup for 850MHz. Then connect the load to the DUT port without threading it onto the socket. Observe the screen, and begin screwing the connector onto the socket. Notice that as the load is tightened into the socket, the return loss changes dramatically-as much as 30dB. The experiment shows how important it is to terminate all UHF system connections

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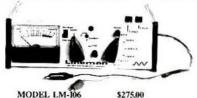


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Table 1-Use this chart to convert return loss to VSWR. RETURN

LOSS	VSWR
-6.0dB	3:1
-9.5dB	2:1
- 15.0dB	1.5:1
- 20.0dB	1.2:1
-30.0dB	1.06:1

properly. (Try making the same test with a wattmeter!)

Performance adjustments

Use the swersweep to adjust RF systems and component equipment for optimum performance.

· Antennas-Swersweeping reveals at a glance the usable frequency range for an antenna, a real advantage when it comes to trimming and adjusting mobile antennas, especially the glassmount variety.

Figure 4 on page 67 shows the swersweep of a Decibel Products DB420 broadband UHF base station antenna. Notice that its SWR is less than 1.5:1 from 450MHz to 470MHz.

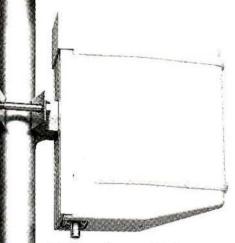
Compare this base station antenna plot to Figure 5 on page 70, the swersweep of a 5dB mobile antenna mounted on a car's trunk lid. The mobile antenna's response shows that the antenna offers an acceptable 50Ω match across a 15MHz span, in contrast to the base station's usable range of 20MHz.

Coaxial cable—Use the swersweep

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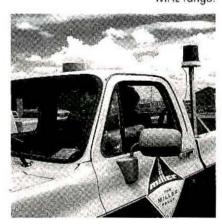
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SRL-501R3 CE

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where smaller is better

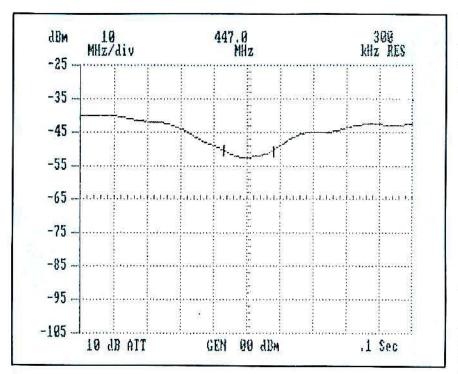


Figure 5. Compare Figure 4's base station antenna plot to this swersweep of a 5dB mobile antenna mounted on the trunk of a car. The antenna offers an acceptable 50Ω match across a 15MHz span.

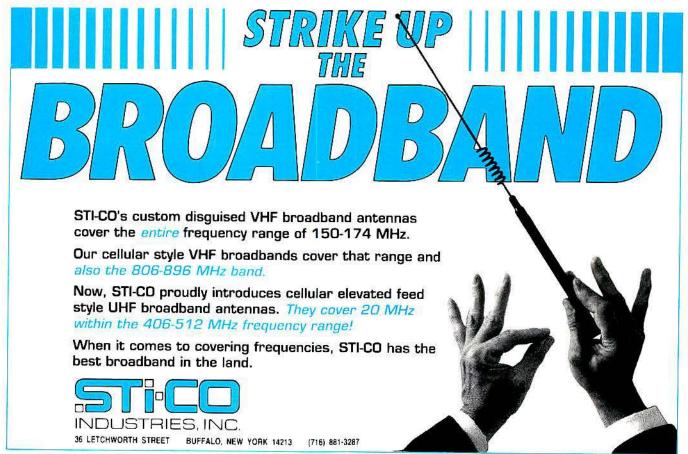
to test transmission line.

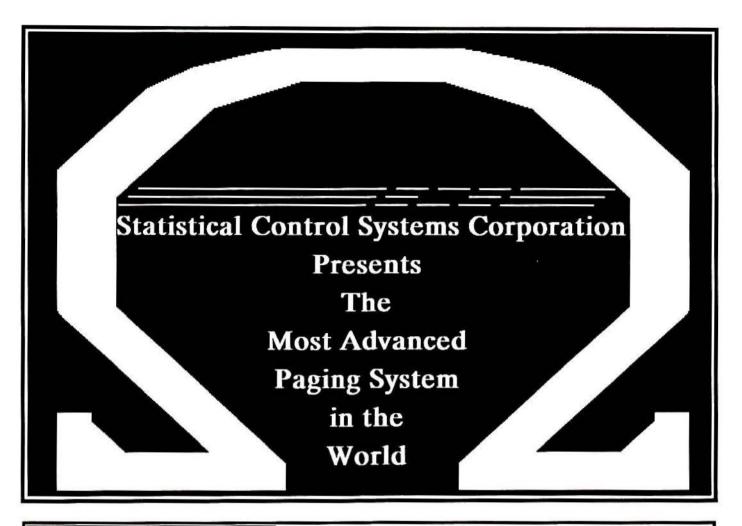
The swersweep can be used to measure the performance of coaxial cable installed on a tower.

Use the swersweep to test transmission line.

It can be used to trim a transmission line to an optimum length for matching the transmitter output impedance when the cable is used to connect an antenna with high SWR.

For example, cut a 3-foot piece of RG-58 coaxial cable and terminate it at







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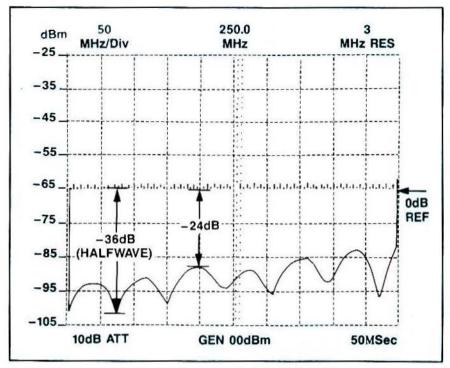


Figure 6. A 3-foot section of RG-58 coax terminated with the calibrated load shows an SWR less than 1.155:1 below 500MHz. At 75MHz, the halfwave resonant frequency, SWR drops to 1.03:1.

one end with the calibrated load as shown in Figure 6 at the left. Connect the other end to the DUT port. Notice that the SWR is less than 1.155:1 (return loss is less than -24dB) below 500MHz

You can change this 'sweet spot' resonant frequency by ...

and drops to 1.03:1 (a return loss of -36dB) at 75MHz.

It happens that 75MHz is the halfwave resonant frequency for 3 feet of RG-58 coax. You can change this "sweet spot" resonance to any desired frequency by changing the length of the cable.

After an antenna is tuned to resonance and the transmission line is installed, swersweep the antenna and coax from the transmitter end of the coax. As you

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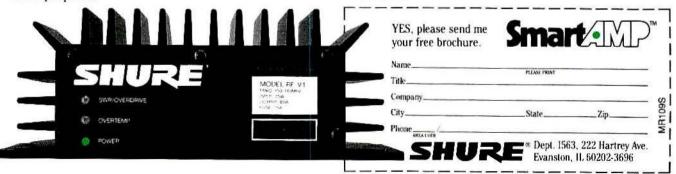
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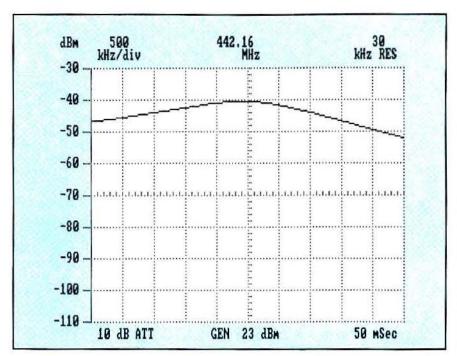


Figure 7. This insertion loss trace for a duplexer's transmitter-pass side was made with a tracking generator and a spectrum analyzer, but without the swersweep. As a tuning rod in the transmitter-pass section is turned, the response as shown barely would change, making a proper adjustment difficult.

observe the response on the CRT, trim the coax to achieve an optimum SWR.

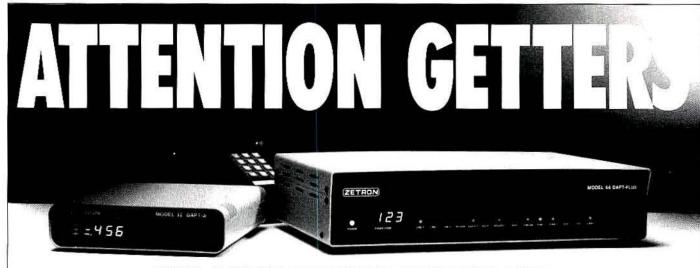
· Filter tuning-Two-way radio communications systems often use a notch duplexer, a specialized filter.

Figure 7 at the left shows the insertion loss for the duplexer's transmitterpass side. The measurement was made with a tracking generator and a spectrum analyzer, but without the swersweep.

Tuning a duplexer with a tracking generator has been one of the best practical methods. As a tuning rod in the transmitter-pass section is turned, the response as shown in Figure 8 barely would change.

But with the transmitter-pass section connected to the DUT port of the swersweep, a dramatic change in SWR response is observed as a tuning rod turns. (See Figure 8 on page 75.) The swersweep shown in Figure 9 is what the transmitter sees.

Tuning a duplexer with the swersweep offers greater precision because the conventional method does not allow a tech-



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nician to reach an optimum adjustment. If the duplexer is adjusted only by the conventional method, the transmitter might be left operating into a high SWR. a condition that increases the potential for intermod.

An appropriate service monitor and swersweep combination costs about \$10,000.

Select a service monitor that includes:

- · all of the capabilities necessary for conducting radio communications testing.
 - · a tracking generator.
 - · a spectrum analyzer.

As radio equipment technology advances and as equipment manuals begin referring to swersweeping, service shops will need the necessary instruments to perform swersweeps. Not only will swersweeping allow technicians to work on modern equipment that may require the test, it allows older systems to be serviced more quickly and to be maintained at a higher level of performance.

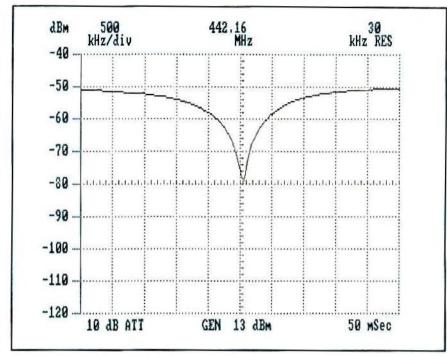


Figure 8. The duplexer's return loss measured with the swersweep shows a sharp null. Tuning is more precise, allowing a lower SWR to be reached, and helping to reduce the potential for intermod interference. Slight adjustments in the duplexer tuning rods make dramatic changes in the SWR trace.



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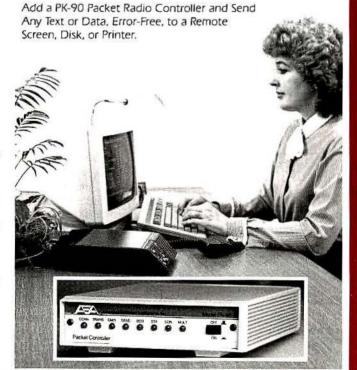
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Why undesired propagation causes radio interference

For the mobile radio service shop, customer complaints tend to increase during periods of unusual radio propagation. Ionospheric propagation, ducting and knife-edge diffraction may cause interference.

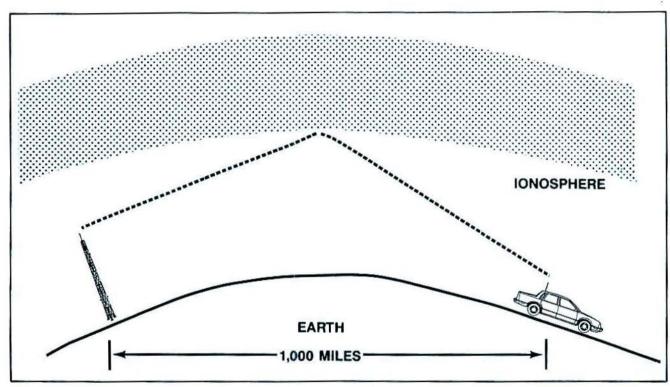


Figure 1. At times, the lonosphere refracts signals back to earth. Returning signals cause interference to local communications, reducing range. Tone and digital squelch may prevent unwanted voices from being heard, but range stays reduced.

By Roald Steen

Two-way radio users sometimes suffer interference from other distant, cochannel users, but not at other times. Unusual or sporadic propagation modes are the cause. Propagation refers to the way in which radio waves travel through, and are affected by, the en-

Steen is an electronics instructor and free-lance writer. He has worked as a two-way radio technician, and he lives in Woodbury, MN. vironment. Propagation is one of the factors that affects radio range.

Radio wave propagation affects all radio services. For frequencies below 30MHz, propagation over long distances is made possible by a quality of the ionosphere, an upper atmospheric layer, that allows it to refract radio waves to bend them toward the earth.

Occasionally the ionosphere returns to earth mobile radio system signals in the 30MHz to 50MHz VHF lowband, producing what commonly is known as "skip" interference. The interference is called "skip" because the signals "skip" over several hundred miles where they cannot be heard outside the local communications area, only to return to earth a great distance away. (See Figure 1 above.)

Refraction from the ionosphere

Ionospheric propagation and the interference it sometimes causes to VHF lowband radio communications is one reason for the decline in the band's popularity.

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Skip interference

Dallas Drda knows about VHF lowband propagation. He supervises the electronics section of the Nebras-ka Department of Roads, Lincoln, NE. The department uses 2,400 mobile units and 25 base stations on 47MHz.

"On our frequency we get a lot of problems with skip interference from Mexico," he said. "It appears Mexico has different laws governing the frequency use: They use repeaters at VHF lowband; in the United States, repeaters are not permitted in that band."

Drda said his system is equipped with continuous-tone controlled squelch system (CTCSS) subaudible tones, so hearing the interference is not a problem. "But it desensitizes our receivers."

Not all of the department's drivers use CTCSS. "Some want to hear every communication, so they use carrier squelch and can hear skip interference." Drda said.

The ionospheric propagation follows the sun. "We notice that in the morning we get skip from the east, in the afternoon from the west and during midday from all over, but a lot from Mexico. When the sun is overhead, the skip comes from everywhere, but signals from the coasts are not as strong during midday."

strength of the ionosphere's refractive layer. Although the sun always emits ultraviolet light, areas covered by sunspots emit more ultraviolet than other areas. Hence, the more sunspots, the more ionospheric interference at VHF lowband.

The number of sunspots rises and falls in an 11-year cycle. Currently, the cycle is nearing its peak.

Ionospheric propagation varies with the seasons because the duration of its exposure to sunlight varies with the seasons.

VHF lowband signals returned to earth by the ionosphere may cover the

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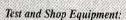


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entire continent. Many users of lowband radio systems have stories of vehicles occasionally dispatched by another mobile system dispatcher thousands of miles away. In one such instance, a vehicle in Minneapolis was dispatched by a dispatcher in Hawaii; the Hawaiian address matched the Minneapolis address.

Wind shears associated with thunderstorms may collect enough ionized particles to refract VHF lowband signals and return them to earth. Long-range communications (or interference) are possible when thunderstorms occur.

Radio waves may be conducted along the boundary between dissimilar air masses, such as a weather front. Known as "ducting," this propagation occurs most often over water but is common in west coast valleys.

VHF and, less often, UHF signals thus can reach astonishing distances over water. It is common for maritime communications in the VHF band to reach well beyond the horizon.

But normally, frequencies above 30MHz have a range limited to the line of sight. Putting an antenna at an elevated location increases the range, so most base station and repeater antennas are placed on towers or rooftops.

The lowest atmospheric layer, the troposphere, tends to refract and bend radio waves slightly. The refraction extends radio coverage somewhat beyond the horizon. The effect is more pronounced at VHF lowband than at VHF highband or at UHF.

Other propagation effects extend radio range, such as knife-edge diffraction. Radio waves that pass over a ridge or hill tend to be bent down toward the ground beyond the hill. The effect is more evident with sharper ridges. Reception on the other side of the hill may be weak, but enough signal may pass to enable users on opposite sides of a hill to communicate—or receive interference. (See Figure 2 on page 80.)

Reflections extend range. Radio waves may be reflected from hills and mountains. Multiple reflections along a mountain range may extend the distance spanned by radio signals.

Mobile radio systems are designed to cover limited areas. Although longrange radio propagation is an advantage for some radio services, usually it becomes a nuisance for the mobile radio service shop.

Complaints of interference and receiver problems tend to peak during periods with unusual radio propagation. Many users may in turn complain about the quality of the radio service.

Some of these complaints stem from the expectation of high-quality communications to which many mobile radio service customers become accustomed. In the early days of mobile radio, when a large proportion of the systems operated at VHF lowband, interference from distant stations that happened now and then simply was something the radio user had to tolerate.

Modern mobile systems work so well that many users rarely are exposed to interference from distant co-channel users. Consequently, radio users have become accustomed to the luxury of a channel free from interference. When the channel is subjected to one of the rare instances of long-distance propagation that brings interference, the radio user may become upset. Complaints about the inferior quality of the radio channel are directed to the radio service shop.

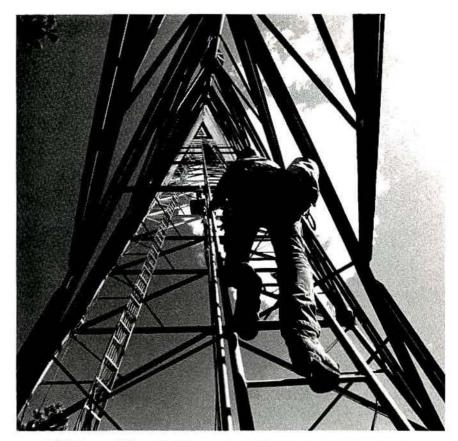
Long-distance radio propagation is as difficult to control as the weather. It can occur on all radio channels in the mobile radio service. When it occurs, it simply may have to be accepted by the radio user.

CTCSS, DCS systems

Continuous-tone controlled squelch system (CTCSS) and digitally controlled squelch (DCS) are among the remedies that may reduce complaints during periods of extended-range propagation. With these control systems, the user only hears other radio services with matching tone or digital signals, making audible interference less likely.

Lack of propagation is at the other extreme of propagation problems. In twoway radio systems, even a weak handheld radio can display an amazing range along the line of sight. But the line-ofsight operating condition is rare. Usually, some obstruction lies between any two radio users.

On the other hand, some terrain features or man-made structures to one side or the other of the obstructed line-ofsight path usually sustain communication by bouncing the radio wave along an angled path that bypasses the ob-



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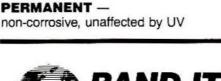
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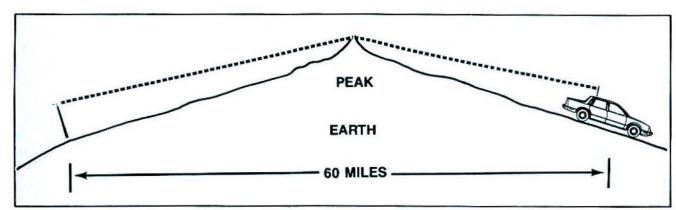


Figure 2. Radio waves that pass over the edge of a hilltop, mountaintop or tall building may be diffracted back to earth. This 'knifeedge' diffraction may extend communications—or Interference—beyond the horizon.

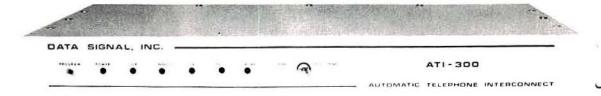
struction. Other terrain features or structures may create a knife-edge refraction that sustains communication. As a result, it is common to find that communication between two radio users is possible, despite intervening obstructions along the line-of-sight path.

The weakest link in most systems is the hand-held radio. Because of obstructions that block most line-of-sight radio paths within the radio horizon, the communications range between two handheld radios used without the benefit of a repeater may be limited to a couple of miles.

In downtown areas of large cities, tall buildings obstruct radio waves. But at the same time, they bounce the radio waves. The radio system, therefore, may cover the area fairly well, despite the obstructions. Once again, it is the handheld radio that may have insufficient power to communicate from some locations. The more powerful mobile radio, with its efficient antenna, may have the ability to communicate from the same locations. (See Photo 1 on page

To support important radio services in a city, satellite receivers may be used

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to achieve good coverage. With wellplaced satellite receivers, communications from hand-held transceivers are reliable from most locations. (In this context, "satellite" means "remote" or "auxiliary," not earth-orbiting.)

Radio waves are attenuated greatly when they travel through building walls. Yet hand-held radios often are used within buildings. It is not surprising that communication with hand-helds is difficult from some rooms or areas within most buildings.

The radio user often finds that an interrupted communication can be restored by walking to another position a few feet away. The best propagation from a building is found near a window.

Locations with the least favorable radio propagation are basements, tunnels and cellars. Communication from tunnels to units above the ground often is impossible. The earth above the tunnel effectively shields it from radio waves above the ground.

Special remedies can support radio communication within tunnels and other

Propagation modes

- lonospheric refraction
- □ Terrain reflections
- □ Tropospheric ducting
- ☐ Knife-edge diffraction

underground systems. One of these remedies uses slotted coaxial cable placed along the length of the tunnel. The cable acts as an elongated antenna to carry signals throughout the tunnel. Slotted coaxial cable is used in mines and other locations where underground radio communication is needed.

Tunnels act as waveguides, so in a tunnel unobstructed by metal doors or other barriers, two radios may communicate over fairly long distances. In subways and other underground systems, placing repeaters or satellite receivers inside the tunnels may result in reliable radio communications.

Polarization

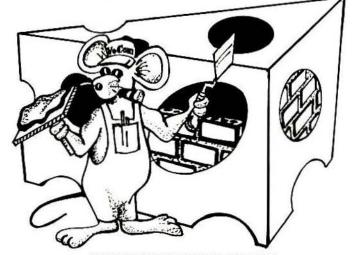
Another important concern in radio propagation is polarization. When the transmitting and receiving antennas have different polarizations, the resulting attenuation reduces range. In the mobile radio service, vertical polarization is universally used. A vertical whip antenna has vertical polarization.

Antenna design influences propagation. Directional antennas improve propagation in the directions that the antenna is designed to cover well, and attenuate propagation in other directions. Well-designed antenna coverage patterns improve radio propagation in the desired directions.

Most mobile radio repeater or base station antennas are omnidirectional and they have gain. They broadcast a

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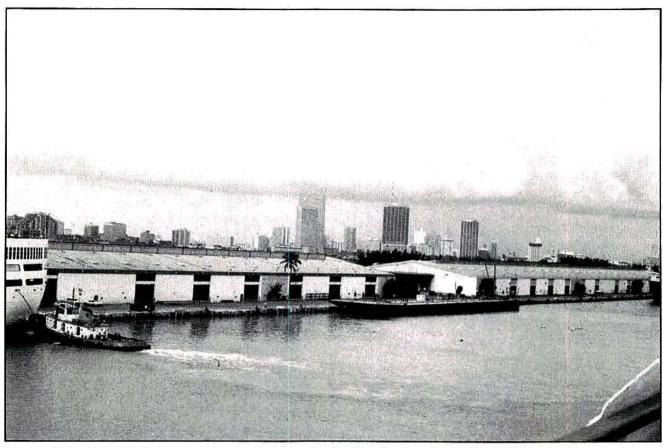


Photo 1. Tall buildings may help or hinder radio communication, blocking signals at times and providing reflections or knife-edge refractions that sustain communication at other times.

stronger signal compared to the most simple antenna design, the dipole. With a gain antenna, signal energy is directed toward the horizon.

Too much gain may be undesirable. For a radio system intended to cover a

limited downtown area, a high-gain antenna placed atop a tall building actually may tend to overshoot much of the area expected to be covered.

For radio systems built to cover a limited area, it may be better to place the antenna on a shorter building. It also may be advantageous to use antennas with less gain, or an antenna that tilts the signal energy downward.

Foliage may influence propagation, especially in the UHF bands because the radio wavelength is about the same dimension as leaves and pine needles. Users of UHF hand-held radios may find the range of their transceivers improves during winter.

Modern mobile radio systems are convenient to use and offer reliable coverage. But propagation occurs from time to time that brings unavoidable interference from distant stations. Well-planned repeaters, antennas and the use of satellites reduce the effect of propagation problems.

CHECK THIS OUT!

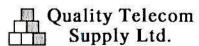
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Private land mobile association seeks radio-user members

Via a direct-mail solicitation that includes copies of a monthly bulletin, the American Private Radio Association (APRA) offers \$25 annual memberships. Private land mobile radio licensees are eligible for "active" membership. Others may apply for associate membership.

APRA "was founded to provide a strong and unified voice of private radio users before the FCC," the mailing

Directors include James Kay of Buddy Sales, Reseda, CA; Kenneth Hoehn of Teletech, Dearborn, MI; APRA president Mark Dobronski of the Arizona Department of Corrections, Phoenix; and the association's correspondent, Steve Black of Esquire Homes, Phoenix.

"APRA supports an openly competitive frequency coordination environment as being the most logical and fair method of protecting the public in-

terest," Black said. "Spectrum is not here to be sold by frequency coordinators, but frequency coordinators seem to take that approach in the way they dole out space."

Black continued: "Even when field studies were permitted as an option, frequency coordinators were involved 90% of the time, so they have to take the lion's share of the blame."

In addition to seeking change in the frequency coordination process, Black said APRA wants to steer the FCC toward advanced technologies. He said the association would participate in rulemaking proceedings by filing petitions and comments.

Formed in mid-March, APRA uses a maildrop and telephone answering service as points of contact. APRA can be reached at 2021 L St., N.W., Suite 250, Washington, DC 20036; 202-429-9795.

PacTel, Teletrac team to form radiolocation systems

PacTel, San Francisco, and North American Teletrac will offer a landbased radiolocation transmission network. The PacTel Teletrac joint venture has been licensed by the FCC to build and operate radiolocation networks in the top 30 metropolitan areas.

By the end of 1991, PacTel Teletrac expects to establish networks in 17 metropolitan areas, with the 13 remaining cities to be completed by the end of

Alliance markets Cobra accessories

Alliance Research Corporation, Chatsworth, CA, is marketing Cobra cellular telephone accessories under a licensing agreement. Cobra, a division of Chicago-based Dynascan, carries cellular antennas, mounts, mics, adapter kits and other accessory items.



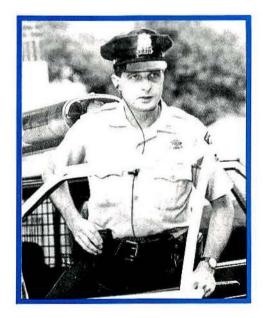
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News

Radio Club names Fellows, award recipients

The Radio Club of America elevated 36 of its members to the grade of Fellow at its June 20 meeting. Certificates will be awarded to these individuals at the club's annual banquet Nov. 17 at the New York Athletic Club, New York, In addition, 10 awards will be presented.

Dr. G. William Troxler, president of Capital College, Laurel, MD, will deliver the banquet's keynote address.

Fellowship status includes: Jack G. Beverly; Aldo A. Bottani Jr.; Raymond L. Collins; Mercy S. Contreras, MRT associate publisher and national sales manager; David N., Corbin; David M. Crawford; Theodore R. Faust; W.H. Galpin; Dr. Albert Helfrick, P.E.; Col. Arthur D. Hendricks; Lt. Gen. William Hilsman; Kenneth A. Hoagland; William S. Hoovler; Lt. Col. Robert J. Howell; F. Jay Huber Jr.; David E. Hubertz; Duane L. Huff; and Reuben A. Isberg, P.E.

Fellows also include: Joel I. Kandel:

Seymour Krevsky; Howard L. Lester; Robert W. Maher; Roy E. Place; June Poppele; Edward J. Reichler; John W. Reiser; Stanley Reubenstein; Warren C. Struven; Frederick G. Suffield, P.E.; Derek Turner; Harry Vorperian; Col. John G. Webb; Robert W. Weir; Ralph O. Williams; Walter B. Williams; and Jan A. Zachariasse.

Walter B. Williams was presented a Fellow award on May 3 in St. Clair, MI, due to health reasons. A Fellow plaque was presented to Zachariasse in July in Cambridge, England, upon his retirement from Philips RCS.

Awards recipients include:

- Sarnoff Citation-William Endres
- Fred M. Link Award-Mal Gurian
- Henrie Busignies Memorial Award-Avery G. Richardson
- · Allen B. DuMont Citation-Kenneth A. Chittick
- · Ralph Batcher Memorial Award-Dr. James E. Brittain

- · Lee de Forest Award-Fred Shunaman
- President's Award—Joseph R. Sims
- · Pioneer Citation-Capt. William G.
- Special Services Award—Dr. Eric D. Stoll
- Jack Poppele Broadcast Award— Leonard R. Kahn

The Jack Poppele Broadcast Award is a new award.

Special recognition will go to Hugo Cohn, Fellow and life member, for being the oldest living member. He is 102.

Mark Antennas observes 40th anniversary

Radiation Systems' Mark Antennas division, Des Plaines, IL, marks its 40th anniversary this year. The company was founded in 1949 and was purchased by Radiation Systems in 1984. Mark Antennas manufactures parabolic grid antennas and cell-site antennas.



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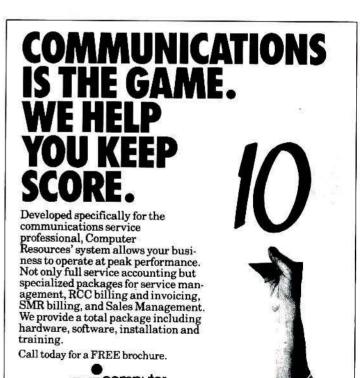
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CT update

Association of Communications Technicians strengthens technicians' credentials

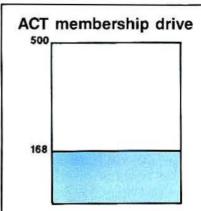
In June 1988, the National Association of Business and Educational Radio (NABER) began promoting membership in one of its sections, the Association of Communications Technicians (ACT), via a series of efforts. As of May 10, 1989, 410 new members had been recruited following an initial mailing of literature to 2,400 non-member technicians. The increase equals a response rate of more than 17%, extremely high for direct mail. A 2% to 3% response to direct mail promotions is considered "good" in most campaigns.

Why has the promotion been so successful? Ian Wright, vice president of Dominion Communications, Colonial Heights, VA, and chairman of the ACT Council said: "It is because ACT is the only association to focus on the needs of land mobile technicians. When land mobile technicians see the benefits that an association such as ACT provides, most of them will invest in membership."

Joe Gately, vice president of Gately Communications, Hampton, VA, pays his technicians' membership dues. "ACT membership is a good way for my technicians to get troubleshooting tips and to learn about new technology, Gately said. "To be part of a national association is good for their professional development.'

More than 2,100 technicians belong to ACT. Senior members total more than 90%. Only NABER-certified technicians may hold senior membership. Commenting on why so many members hold the senior grade, Wright said: "Technicians who have earned their NABER certification usually have done so because they want to increase their professional credentials. Once they earn their NABER certificate, they see ACT as a good way to keep on top of their trade and strengthen their credentials.

One-year memberships in ACT cost \$37 for the general grade and \$42 for the senior grade.



During its March 1989 council meeting. ACT set a goal of adding 500 new members during the following 12 months. As of July 15, 168 new members have joined.

Information

For information about ACT, call 800-759-0300. Ask for "technician serv-

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Federal officials speak at national public safety communications conference

Representatives of the House Energy and Commerce Committee, the National Telecommunications and Information Administration (NTIA) and the FCC spoke to audiences at the Associated Public-Safety Communications Officers' national conference in August.

· David Leach-House committee staff member David Leach said the committee wants to eliminate license application processing fee exemptions and boost the minimum fee to \$35. The move is intended to shift a substantial portion of the FCC's funding from taxes to fees, helping to reduce the federal deficit.

He spoke about House bill HR 2965. He said the bill would require the federal government to re-examine its use of radio frequency spectrum and transfer as much as 200MHz of spectrum from NTIA to FCC jurisdiction for use by state and local governments and the private sector.

The bill sets a three-year period for the government to review its frequencies and for an advisory committee to report its findings to the secretary of commerce. Six months later, the president would begin revoking NTIA licenses for frequencies to be transferred to FCC jurisdiction. The FCC would have 10 years to reassign the frequencies. "This bill has succeeded in focusing attention on how the government allocates spectrum," Leach said.

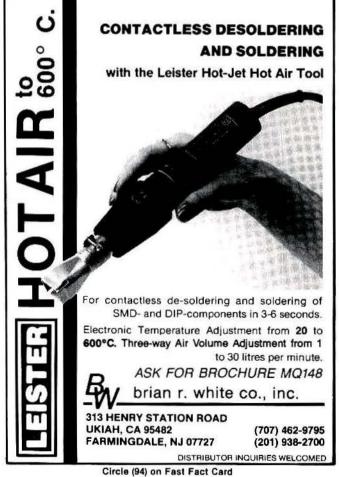
 Richard D. Parlow—NTIA office of spectrum management associate administrator Richard D. Parlow, whose agency stands to lose control of spectrum under HR 2965, said automated control and reporting services place demands on more frequencies and wider bandwidths.

Aside from HR 2965, the NTIA is focusing on preparations for the 1992 World Administrative Radio Conference that will revise the international allocations table for mobile communications. Members of the U.S. delegation will be expected to do what they can to influence the conference report to accommodate "needed flexibility for national uses," Parlow said. In part, those accommodations mean inserting U.S. "footnote" exceptions to the international agreement when necessary to suit American requirements.

• Ralph Haller-FCC private radio bureau chief Ralph Haller said his office has stepped up its enforcement of channel construction and loading requirements. He encouraged anyone with knowledge of licensed but unbuilt systems to report them to the bureau.

"Watch your slow-growth deadlines," he warned the public safety communications officers. Once the FCC takes back channel assignments for failure to meet deadlines, the licensee may not be able to get them back "even though it may be a public safety agency."





ew products

Synthesized VHF mobile has 16 channels, 40W RF output

The SM-4150 synthesized VHF mobile from Maxon Electronics offers as many as 16 dealer programmable channels and 40W RF output. Its microprocessor controls a mix-andmatch of any combination of tone-coded or digitally coded squelch, time-out timer and busy-channel lockout features and capabilities.



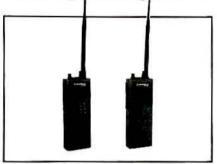
Circle (218) on Fast Fact Card

Two-tone decoder fits King portables, mobiles

The KRO-15 plug-in two-tone decoder for King portable and mobile radios can be programmed from the radio's keyboard. It includes DTMF signaling with multiple memory dialing features. The decoder, from Transcrypt, works with most two-tone formats and includes group-call features.

Circle (201) on Fast Fact Card

900MHz portable operates in trunked or conventional modes



Circle (255) on Fast Fact Card

The MTX-900 dual-mode portable from Motorola can be switched from trunked to conventional systems. It can operate on multiple systems, including on as many as six different Motorola 900MHz Privacy Plus Radio systems or as many as 18 conventional channels or a combination of both. Distinct audible tones inform the user of an incoming call. The radios have simplex (talkaround) capability.

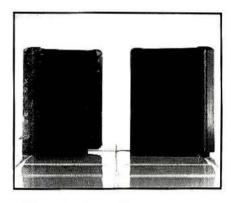
'Car kits' include power cord, antenna

Ora Electronics offers five car kits that include a dc cord and a cellular antenna for use with most portable and transportable cellular telephones. The dc cord takes power from the car's cigarette lighter socket. The Delta antenna works inside the car.



Circle (208) on Fast Fact Card

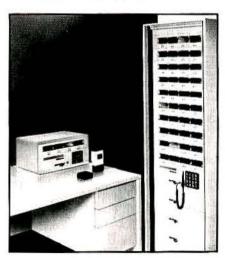
Color pigmentation match restores pager housings



The color pigmentation match (CPM) enhancement process formulated and developed by Fourth Dimension Industry rejuvenates old, dull and dirty pager housings. The process removes labels, adhesives, oil deposits, paint spatters, blemishes, light abrasions and other foreign matter. It gives treated units a new appearance and restores original luster.

Circle (217) on Fast Fact Card

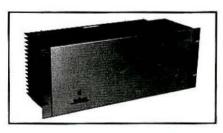
Battery charging system includes safety checks



The RAMSystem battery recharging, analyzing and maintenance system includes a master controller and smart charger cards. The BatteryPro system features power outage protection, five overcharge prevention checks, battery fuse protection, safety checks and battery tracking. The modular system's 16bit master controller houses as many as four charger cards. Expansion units may be added. The system can be configured to process batteries to individual specifications. The system comes in deskmount and 19-inch rack-mount configurations.

Circle (239) on Fast Fact Card

RF power amplifiers offer 400W output

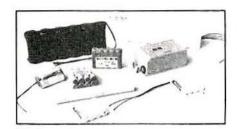


High-power base station RF amplifiers from VoCom operate from 13.8Vdc and offer as much as 400W output. The continuous-duty amplifiers use a dcoperated cooling fan.

Circle (240) on Fast Fact Card

New products

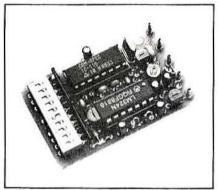
Nickel-cadmium batteries feature high rate discharge



Nickel-cadmium batteries in the PowerPak line feature long life, high discharge rate, continuous charge and resealable safety vent. The batteries mount in any position.

Circle (250) on Fast Fact Card

Two-tone sequential encoder offers changeable timing



Circle (215) on Fast Fact Card

The PE-2P DIP switch programmable two-tone sequential encoder mounts inside a radio or other housing. It allows the radio operator to send a single two-tone sequential paging call. The Communications Specialists product has standard one-second-to-three-second timing for compatibility with the company's SD-1000 two-tone decoder and other systems, such as Motorola Quick-Call II, 1+1 and GE Type 99. Timing may be changed to match other two-tone formats.

Mounting plate fits Panasonic cellular phone



SMC Electro-Mount makes a mounting plate for Panasonic's EB362 transportable cellular phone. It secures the transportable, which slides on and off the plate for quick installation and removal.

Circle (211) on Fast Fact Card

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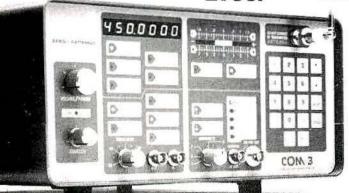
performance circuitry provides remarkable sensitivity for superb, high-resolution frequency analysis and observation. Interference location and characterization is easier than ever. Not only can you see the interference, you can hear it too. A variable bandwidth audio demodulator allows you to detect and audibly identify the interfering signals. In addition, a true frequency counter display speeds center frequency setting and reading. Frequency range covers the entire 1 MHz to 1000 MHz spectrum. Add the optional tracking generator and you can easily tune duplexers, filters and cavities!

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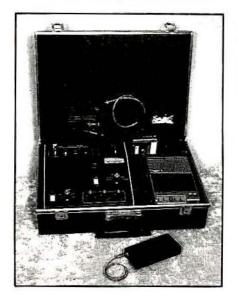
Tone and voice pagers program via IBM-compatible



KeyNote tone and voice pagers from Motorola use Golay sequential coding and 5/6-tone signaling. Programming can be accomplished using an IBM-PC compatible interface, pager coding and optional software.

Circle (228) on Fast Fact Card

Radio surveillance system works on VHF, UHF bands



The VHF and UHF radio surveillance system offered by Spectrum Communications comes in a foam-lined briefcase. It includes a long-range body transmitter, a miniature lapel mic, a highly sensitive and selective receiver with built-in battery and an ac supply. The system has audio filters, a signal strength and battery condition meter, a tape recorder, cables and an antenna.

Circle (227) on Fast Fact Card

Coaxial test cable assembly also serves as a jumper cable

Type 39812-11 coaxial test cable assembly with SMA plug connectors features FSJ1-50 Superflexible coaxial cable with 50Ω impedance. Although it is designed for testing applications, the **Andrew** cable assembly may be used as a jumper in equipment racks. It comes with an SMA plug connector, Andrew type 41SWS, at each end.

Mountaintop repeater has power-saving electric circuits

With a standby current drain of 10mA, DX Radio Systems' "mountaintop repeater" meets requirements for remote repeaters powered by photovoltaic or battery primary power sources. Onsite and off-site troubleshooting may be conducted through optional modules.

Circle (203) on Fast Fact Card



Circle (222) on Fast Fact Card

Lapel speaker mic fits portable transceivers

Astatic T₂M-955 and T₂M-956 speakermics for portables incorporate a DTMF dialing generator. Made by Conneaut Technologies, the mics work with any radio with inputs for an external electret speakermic. The speakermics are available with I0-number autodial with last-number redial.

Circle (210) on Fast Fact Card

Trunked two-way radio delivers 15W RF output

The LTR 8604 trunked dash-mount mobile radio features 15W RF power, four-system LTR trunking, system scan and conventional 800MHz channel operation. The E. F. Johnson mobile includes EEPROM programming.



Circle (225) on Fast Fact Card

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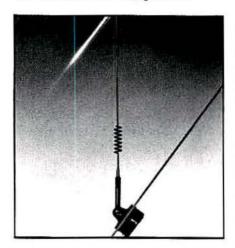
VHF, UHF portables have 6MHz spread, 5W RF output

Frequency-synthesized two-way FM portable radios from Midland LMR can be programmed for as many as 16 channels. VHF models (70-145) operate in the 136MHz to 150MHz, 150MHz to 162MHz or 162MHz to 174MHz frequency ranges. UHF models (70-245) operate in the 450MHz to 470MHz range. Both are capable of a 6MHz frequency spread at rated specifications and both have 5W RF output, switchable to 2W.



Circle (212) on Fast Fact Card

Glass-mount antenna serves cellular telephones



The Allgon-Glass made by Allgon Antenn uses a "nipple system" for connecting different lengths of whips and to exchange them if necessary. It eliminates the need for crimping and soldering the connector.

Circle (223) on Fast Fact Card

Mobile radios combine crystal, micro control

Crystals control operating frequencies and a microprocessor controls encoding and decoding options for **Uniden's** Force 100 mobile radios. Options include a multiple CTCSS and DCS encoder-decoder and a two-tone decoder.

Circle (230) on Fast Fact Card

Response system assists paging operation functions

Subscriber Computing makes the VoiceMax DTMF and voice response system that enables a Touch-Tone dialing telephone to function as a computer workstation. It allows resellers, agents and sales representatives 24-hour-a-day access to activate pagers, add phone numbers, look up call counts and perform other pager maintenance and inquiry functions from any Touch-Tone telephone.

Circle (216) on Fast Fact Card

Repeater monitoring tool displays tone codes

Model 8B repeater monitoring tool made by **Zetron** connects to any receiver, scanner or mobile radio and decodes and displays the tone or code of any radio currently using the radio channel. The unit encodes, too, allowing the user to select and transmit on any specific tone or code. The unit encodes and decodes 38 CTCSS tones, 104 digital tones and DTMF tones.

Circle (221) on Fast Fact Card



Frankly, DX Radio Systems Makes The Competition Look...Well...



The Exicom Base/Repeaters from DX Radio Systems are so advanced, they make other products look like kid stuff. First, the Exicom Systems are incredibly flexible, offering total control through their completely modular design – easily adaptable from simple to complex configurations. The fully plug-in

Exicom system modules include: Receivers, Transmitters, Controllers, Subscriber Line Interfaces, Exchange Line Interfaces, Duplexers, Power Supplies and lots more.

Secondly, they are incredibly compact, allowing even the most complex system configurations to fit into a standard 19" rack with plenty of room to spare. And speaking of small, the Exicom system modules also boast a miniscule stand-by current draw (less than 20 mA), making them perfect for battery operated Base Station/Repeaters in either portable or fixed configurations.

Go ahead, put the Exicom system in the most severe temperature or RF environment, and you can count on it to perform year after year. And DX Radio Systems doesn't just stop at

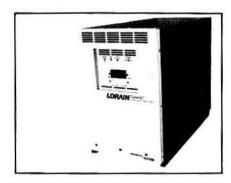
repeaters – we also carry state-of-the-art Rural Radiotelephone Links, Polling systems and loads more. Give us a call, let's talk about your needs, and we bet you'll think the competition looks primitive too.



DX Radio Systems, A Division of DX Communications, Inc., 3336 San Fernando Road, Los Angeles, CA 90065-1417, PHN: 213-257-0800, FAX: 213-254-3210, TWX: 910-346-7015. ©1989 DX Communications, Inc.

New products

Backup system provides 30 minutes of reserve power



The ConstAC uninterruptible power system provides 30 minutes of reserve power for system operating from an ac source in the event of main system failure. The Lorain Products unit has four scaled lead-acid batteries that are recharged by the unit when normal power is resumed. The unit operates from a 120Vac, 50Hz single-phase grounded outlet.

Circle (252) on Fast Fact Card

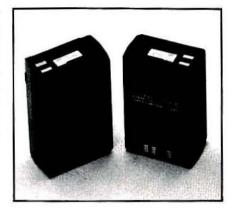
DTMF decoder reprograms locally or remotely

Sierra Digital's TTD-4S microprocessor DTMF decoder installs in base, desktop and mobile radios to provide selective-call, group-call and all-call using one- to 11-digit codes. A standard

DTMF keypad programs the decoder locally or remotely. The manufacturer's datasheet lists specifications and 15 additional features.

Circle (315) on Fast Fact Card

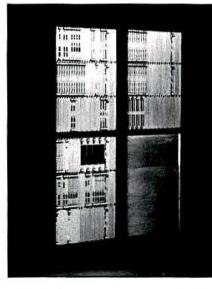
Battery capacity up 20%



The FNB-12(S) battery from W & W Associates has 20% more capacity in a package the same size as the FNB-12. It is interchangeable with all FNB chargers.

Circle (342) on Fast Fact Card

Large-capacity paging system boasts 170,000-sub capacity



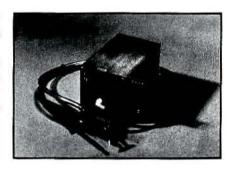
With 192 ports and a capacity for 170,000 subscribers, the Digital Switching System-3 (DSS-3) paging system introduced by Glenayre/BBL allows backward compatibility with existing System III, DLM, alpha modules and remote trunk concentrators. The system offers programmable call flows for custom prompts, name insert, headertrailer prompts, reminder page, numeric retrieval and multilingual voice prompts.

Circle (206) on Fast Fact Card

Desoldering station contains temperature controller

The Endeco model 7200 temperaturecontrolled soldering station operates on shop air of 40 pounds to 120 pounds. The unit's on-off controller maintains temperatures. Offered by Leads Metal Products, the station includes a standard Endeco 3-wire grounded iron with a 450° F-to-950° F temperature range.

Circle (266) on Fast Fact Card



Interconnect, repeater unit boasts nine operating modes

Model 8200 full duplex interconnect and repeater controller features a builtin keyboard, digital display, 90-number auto-dialer; keyboard programmable CW ID and last-number redial. The Connect Systems unit allows nine selectable operating modes: full duplex interconnect; semi-duplex interconnect; semi-duplex privacy; duplex base station interconnect; duplex repeater interconnect; repeater controller with duplex



patch; dial-up remote base; dial-access paging terminal; and talk-back paging terminal.

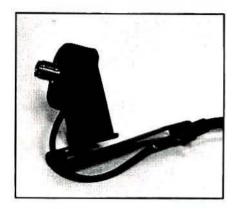
Circle (264) on Fast Fact Card

Instructions cover handset-programmable phones

Programming instructions for nearly all handset-programmable cellular phones are available from Curtis Electro Devices. Intended only for cellular installers, the "Curtis Namfax" programming guide lists programming steps for nearly 40 model lines and more than 20 brands.

Circle (270) on Fast Fact Card

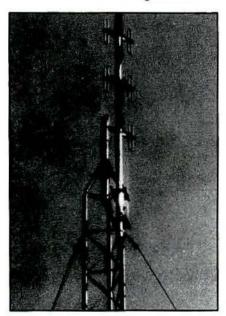
Window-mount antenna clips on vehicle



The WM TNC window-mount cellular antenna from Valor Enterprises clips on a vehicle's window and comes with TNC connector and 14 feet of low-loss cable.

Circle (412) on Fast Fact Card

Metal dipole antennas offer a selection of field patterns



UHF metal dipole antennas manufactured by Antenna Specialists offer omnidirectional, elliptical and directional field patterns. The ASP-2650 series antennas have gold-iridited, solidaluminum dipoles secured to aluminum pipe masts with stainless-steel clamps and hardware. Welded dipole construction increases rigidity and eliminates a potential noise source.

Circle (214) on Fast Fact Card



HAND-HELD OR MOBILE, VHF OR UHF — **MAKE IT A MAXON**

With a Maxon, you can expect optimum performance and be surprised by the low price.

HAND-HELD PORTABLES

These 5-watt/4-channel two-way portables are compact* and lightweight, yet built tough enough to perform under rigorous conditions... year after year. Inside, there's advanced micro-circuitry on a durable FR-4 glass epoxy board. On the outside, there's a rugged, heatresistant Noryl-190® case with a die-cast aluminum control deck, machined aluminum control knobs, and a metal BNC connector. ("HD" models, with a die-cast aluminum "H" frame, meet several criteria of MIL-SPEC 810D and offer an INTRINSICALLY SAFE option for many levels of hazardous conditions.)

MOBILES Add to this a complete list of available Maxon's 30accessories and tone signaling watt/4-channel options, and it's easy to see mobile transceivers, why Maxon portables with their rugged steel are preferred cabinetry, are only 134" high*around the allowing easier installations, even world in smaller vehicles. The faceplate, microphone and optional auxiliary speaker

Plus, all controls feature bright LED indicators and are recessed for protection. Inside, solid state switching and advanced broad band strip technology assure you of spectral purity and frequency stability.

are all made of tough, heat-resistant Noryl-190®.

There's also a wide array of available accessories and tone signaling options.

That's the Maxon lineup... superior 4-channel radios, built to provide top performance for the long haul...and that's why your next order should read, "Make it a Maxon."



10828 NW AirWorld Dr., Dept. 100 Kansas City, MO 64153 • (816)891-6320 Noryl-1900 is a registered tradename of General Electric

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Circle (95) on Fast Fact Card

New products

Replacement batteries fit Motorola cellular phones

Two replacement batteries for Motorola cellular phones allow longer talk time. Model CL6000B-XT for Motorola 8000 series and 850 Express cellular phones is rated at 7.5V with a 1.2Ah capacity. The Alexander battery provides 90 minutes of talk time for the cellular phones, which is extended to 120 minutes for G series phones. Model CL4003B-XT is for Motorola 9500 cellular phones and has 7.5V with a 1.2Ah capacity. It provides the same talk time as the CL6000B-XT. Batteries with



7.5V, 1.0Ah also are available for the phones.

Circle (259) on Fast Fact Card

Computer program shows radio propagation, coverage

The propagation and coverage computer program written by John Murray Associates creates coverage contour plots using digitized topographical data

for SMR, mobile radio, cellular, paging and SCADA systems. The RSPT allows evaluation of alternative sites.

Circle (251) on Fast Fact Card

Numeric display pager receives voice messages

The DVT display pager from Shinwa receives a numeric display page with a voice message or a numeric page. The pager features two addresses, lighted display and volume control for the voice. It stores two 20-digit messages and four tone-only messages. Autoreset, area indicator and low-battery backup are standard.

Circle (456) on Fast Fact Card

Crank-up towers extend from 35 feet to 100 feet

Aluminum crank-up towers feature rust- and weather-resistant tubing. Made by Aluma Towers, towers extend from 35 feet to 100 feet. Tower construction incorporates a heli-arc gas welding procedure.

Circle (256) on Fast Fact Card

Elevated-feedpoint antenna has adjustable angle feature



The operating angle of the ASPD917 elevated-feedpoint cellular antenna may be adjusted to any direction with the Omni-Loc angle-adjusting mechanism controlled by a knurled angle-locking nut. Loosening the nut allows angle adjustment; tightening it sets the angle. The Antenna Specialists antenna does not need a ground plane, so it works on convertibles and in other off-roof applications

Circle (213) on Fast Fact Card

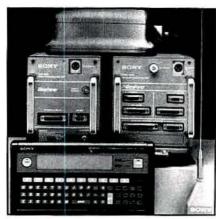
UHF, VHF portables weigh 7 ounces

The HX530 synthesized portables are available in UHF and VHF versions and weigh 7 ounces. The Standard Communications portables have two channels and incorporate a built-in tone for private channel operation. Features include built-in CTCSS capability and programmability through the use of an interconnect cable connected to another HX530 unit. Three battery packs fit the portable: a 400mAh, an optional 600mAh and an optional 400mAh, 8.4V pack.

Circle (427) on Fast Fact Card



Satellite system delivers dispatch, location data



The Sony 2-Wayfarer mobile communications unit uses a radiodetermination satellite system to automatically tag a vehicle's position. The unit features twoway driver to dispatcher communication, remote control, and autodiagnostics and reprogramming. The system includes a satellite communication keyboard and terminal, mobile communications unit, receiver, and interface unit and antennas. Custom menus can be programmed.

Circle (261) on Fast Fact Card



Literature

Workshop papers cover amateur radio education

Proceedings of the ARRL Educational Workshop contain 25 papers on amateur radio education topics presented on June 3. The papers were delivered at an educational workshop during the American Radio Relay League National Convention.

Among the papers are:

☐ "Syllabus for Teaching an Amateur Radio Training Class—Novice and Technician in Eight Weeks" by Monte G. Bateman and Davis M. Egle.

☐ "First Impressions are Lasting Impressions: Positive Imaging for Amateur Radio Instructors" by Scott Larson.

☐ "The Importance of Amateur Radio Instruction at East Tennessee State University" by Robert M. May.

☐ "Assisting Students in Passing the 5wpm, 13wpm and 20wpm VEC Code Exams" by Loraine McCarthy.

☐ "Getting Ham Radio Into the Classroom" by Carole Perry.

☐ "How to Organize a Weekend Novice Class; 'Pre-Study' is the Key to Success" by Gordon West.

☐ "How to Award CEUs to Amateur Radio Class Graduates" by Rosalie White.

"Some Study Hints to Prepare for License Exams" by Larry D. Wolfgang. Circle (393) on Fast Fact Card

Data sheet describes radio modules

A data sheet from Lucas Ledex describes its 2700 series radio modules, showing various configurations that are available. The modules are plug-in line options for model 2504 enclosures and 2506 racks. The modules are available in UHF and VHF. The information details electrical and physical specifications on transceivers, transmitter-only units and receiver-only models.

Circle (307) on Fast Fact Card

Government publication reviews communication

"NTIA Telecom 2000: Charting the Course for a New Century" defines national communications and information priorities for the present and to the end of the century. Topics include privacy; the telecommunications foundation and universal information service in the year 2000; information flows and the protection of intellectual property in the information age; and international and domestic policymaking in the year 2,000. The Government Publications Outlook examines communications and information systems in rural America.

Circle (415) on Fast Fact Card

EMI, RFI catalog includes specs, performance data

The EKS-Norland 52-page catalog of electromagnetic interference (EMI) and radio frequency interference (RFI) shielding and suppression products details specifications, properties and performance data. The products listed comply with FCC regulations.

Circle (476) on Fast Fact Card

Study analyzes digital data test equipment

Communications Test Equipment Market In The U.S. by Frost & Sullivan, predicts that \$840 million a year will be spent on test equipment associated with digital technology, fiber optics and data communications. According to the analysis, companies are willing to spend the testing dollars because many companies are developing their own communications systems to operate with the public. Data communications will be the area where companies invest the most testing costs. The report states that \$127 million was spent in 1988 in this area. The rate of investment is expected to increase over the next few years.

Circle (410) on Fast Fact Card



Report outlines growth in cellular distribution

"Cellular Brand Sales" latest volume covers cellular brand market shares for June 1988. Information in this Herschel Shosteck Associates' report includes shares for mobile and mobile-transportable units, percent of manufacturer's market share and sales estimates.

Circle (423) on Fast Fact Card

Digital cellular radio book outlines technology, history

Digital Cellular Radio by Dr. George Calhoun describes digital cellular and mobile telephone history. The Artech House book analyzes regulatory, marketing and technology issues in basic terms. Digital cellular use is outlined.

Circle (413) on Fast Fact Card

ALARM REPORTING!

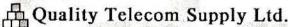
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The B1125 ALARM REPORTING UNIT will satisfy your needs.

The B1125 will talk on any two-way radio and/or public address system with high quality voice synthesis. You can now reliably report any type of alarm condition automatically. It will save you money because response time will be shorter and down time will be less. The B1125 also adds a measure of safety by reporting problems right away. Installation is simple and the B1125 doesn't cost much.

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Challenges, variety in posts attract technicians to trade

Can land mobile radio compete with other industries for good-quality technicians? According to the March "What Do You Think?" questionnaire results, 46.9% believe it can, while 48.2% believe it cannot.

Part of the reason the industry has problems attracting technicians, respondents believe, is because of lower salaries as compared to other electronic technicians as reported in these statistics:

Technicians salaries are	
(Multiple responses)	

Adequate

32.1%

Below other	
electronic technicians	37.1%
Too high	1.2%
Too low	28.4%
Other	7.4%
No response	1000

Readers contend certain job-related considerations inherent in land mobile technical positions help them to overcome the pay obstacle.

Individuals may secure radio repair posts as an outgrowth of ham radio interests, "expanding their ham hobby" or to pursue an interest in radio electronics; enjoy a light, clean work and independence; get started in a career out of school; continue to put military technical school experience to work; and realize a relaxed working atmosphere and a sense of self-management.

Although respondents report some dissatisfaction with their salaries, they appreciate variety in their work as twoway technicians and the challenges the work affords.

"There is the excitement of a challenge. Two-way is different and services a mixture of fields. You go a lot of places working on land mobile," a technicians notes.

"The variety in repairing electronic equipment is an attraction. Mobile radio repair deals with almost every aspect of electronic circuitry, including programming," adds a technician.

"The challenge of doing different things every day and the opportunity to work on different equipment keeps the work exciting," agrees a respondent.

The appeal of RF repair includes: "a chance to see new technology," "the mystique of RF communications" and "RF is a black art-a beckoning mystery.'

Other motivations for land mobile repair employment include: "The freedom from regimentation in a factory or similar setting. The ability to exercise one's own judgment and repair expertise freely."

"The gratification of making things work-this is what attracted me and my techs. This does not appear to be working today."

'The desire, dedication and pride of making something work again. Work-

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ing with RF is unique compared to a TV or high-fi or ball game radio," adds a technician.

Competing with other fields

Respondents that assert land mobile radio can compete with other electronic fields attest "land mobile radio offers a unique working environment not found elsewhere."

"Working conditions and salaries are better than some other electronic specialties," concurs a technician.

"It is still one of the more interesting fields and allows a technician to do a lot on his own motivations," adds a tech.

Ways land mobile employers can continue to compete for qualified technicians include:

- · better salaries.
- paid holidays.
- paid overtime.
- profit-sharing plan.
- new test gear.
- training programs.
- appealing work environment.

Technicians that are not so optimis-

tic about land mobile's ability to compete for competent technicians explain that other industries offer higher wages. "Telecommunications and some industry jobs pay 50% more," notes a reader.

'The starting salary and benefits are not adequate to attract top-notch technicians," adds a reader.

"I would love to get back into land mobile but would have to take a pay cut to do it," a tech agrees.

"At this time, there are too many good-paying jobs in computers and automotive electronics and thus it is hard to keep good techs," comments a respondent.

Advancement possibilities

Besides pay, opportunity for advancement factors into technicians remaining in mobile radio, and many respondents perceive slim probabilities of advancement.

"Advancement opportunities are limited. Service managers are no longer technicians, but PR types and paperpushers," notes a technician.

"One might be moved up to manager, but many companies use business graduates for top positions," comments a technician.

Some technicians contend the avenue for advancement exists in starting up your own shop or service center.

Others describe promotions to sales, consulting, system design and service manager positions.

One technician suggests, "Get out and start your own shop."

Be sure to fill out this month's "What Do You Think?" questionnaire on page 113 so your responses can be included in a future "Feedback" column.

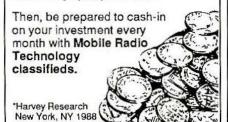


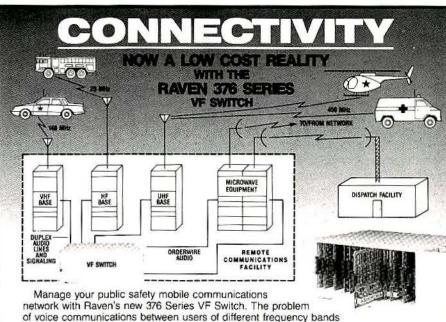
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A single-channel mobile/paging terminal, 4 DID trunks, 2 End-to-End trunks. 500 subscribers.

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An 8-channel mobile/paging terminal expandable to 12 channels. 4 DID trunks, 8 End-to-End trunks, 10,000 subscribers.

Commander DMF-4000

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Johnson

Farrell

Rhodes

Page

Donald D. Johnson moves to Raven Electronics, Sparks, NV, as director of product and market development after directing international marketing and sales for Loral TerraCom.

John J. Farrell, manager of business and industrial/cellular marketing at GE Mobile Communications, Lynchburg, VA, advances to manager of marketing.

Changes at Power Conversion Products, Crystal Lake, IL: Becky Rhodes advances to southern regional sales manager, after receiving a bachelor's and master's degree in business administration while employed with the company. She will relocate to north central Florida.

Leonard E. Page joins Power Conversion as account executive, exiting a sales position with CSE Technologies.

J.F. "Frank" Grenon moves from vice president of sales and marketing of Andover Controls to vice president of business and technical development for Technical Communications Corporation, Concord, MA.

Celltronics, San Diego, names sales and marketing staff: John L. Giannettino, vice president of sales and marketing; Dale L. Holden, sales engineer; Jim L. Alguire, sales administrator; and Rosa R. Ramos, assistant marketing coordinator.

Changes at Syntonic, Harrisburg, PA: Kathleen Gaito, exits a publishing company as assistant product manager to become Syntonic marketing assistant. Jack Hines, a senior communications rep in the Delaware Valley area, advances to regional manager for New Jersey, Delaware and eastern Pennsylvania.

Changes at Tait Electronics sales and manufacturing branch, Houston: Don Scott, vice president of marketing, advances to executive vice president. Terri Burton, dealer marketing support, becomes national sales manager. Tim Hudson is technical sales rep; Scott Quintavalle is service manager; and Janet Rhodes is credit manager.

Changes at Selectone, Hayward, CA: Jean-Pierre Masri becomes engineering technician, moving from a temporary production technician post.

Rick Shinholt leaves an engineering position with Don Cline & Associates, Houston, to join Selectone as applications and development engineer for its Hyperdyne line.









Pinnell

Karamanos

Taylor

Teagan

Appointments at Yaesu, Cerritos, CA: George Pinnell joins the company as national sales manager.

Kevin Karamanos adds duties as Yaesu's western regional sales manager to activities as a vice president of ALERT, Amateur Licensed Emergency Response Team, and as an owner and operator of mountaintop radio repeaters in Southern California and Nevada.

Steve Taylor joins Midland LMR, Kansas City, MO, as federal area manager for the company's eastern sales region.

Cathy Teagan, a production assembler at TPL Communications and DX Radio Systems, Los Angeles, advances to production supervisor.

Ira Citron joins Bomar Crystal Company, Middlesex, NJ, as director of marketing, departing The Russell Agency, Winston-Salem, NC, as publicity manager.

Douglas N. Baker resigns as DADS system development at Federal Express to join Coded Communications, Carlsbad, CA, as vice president of engineering and manufacturing operations.

Robert Pizzimenti becomes president and general manager of Ericsson Paging Systems, Greenwich, CT, exiting as vice president and general manager of Liberty Communications, a Connecticut-based RCC.

Tyler Bryant departs Teletec, Raleigh, NC, as national sales manager to become vice president of sales and marketing for Larsen Electronics, Vancouver, WA.

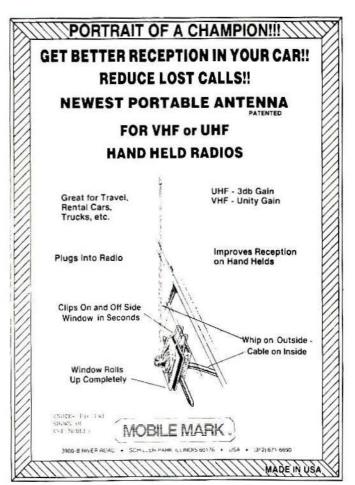
Steven P. Stepansky, transmitter department manager at Spectrum Communications Corporation, Norristown, PA, advances to sales manager.

Jim Rice becomes executive vice president of Unipage, DeSoto, TX, leaving Uniden Corporation of America, Fort Worth, TX, as vice president of its Regency division.

William Cole exits Data Spectrum, Winter Park, FL, as president to become vice president of sales for Sinclair Radio Laboratories, Tonawanda, NY. He succeeds Gordon Mayhew, who has retired.

James D. Dyson, first-line supervisor of Lenexa, KSbased Kustom Electronics, advances to production manager of the company's manufacturing facility in Chanute, KS.





Circle (96) on Fast Fact Card

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3 CT45AAUWAUCENTURY II UHF UNDER DASH MOBILE \$ 6						
PAGER CHARGERS SINGLE UNIT!	,,					
25 NLN-1147A PAGEBOY 2 \$ 10 4 NLN-9580 SENSAR \$ 1	10					
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2 STANDARD #12-120-12 13.6VDC \$ 2	25					
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MISCELLANEOUS	2					
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October

3-8-ITU-COM '89, Palexpo Exhibition and Convention Center, Geneva, Switzerland. Contact: Donald R. Pollock, Telecommunications Industry Association, 312-782-8597.

4-7—Telocator 41st Annual Convention and Exposition, Washington Convention Center, Washington, DC. Contact: 202-467-4781.

14-19-International Association of Chiefs of Police Annual Meeting, Commonwealth Convention Center, Louisville, KY. Contact: 301-948-0922.

16-17-American SMR Network Association Fall Meeting, Ritz Carlton Hotel, Rancho Mirage, CA. Contact: 202-331-7773.

November

1-4-Special Industrial Radio Service Association Annual Meeting, Park Hyatt, Washington, DC. Contact: 703-528-5115.

17-Radio Club of America Annual Meeting and Awards Banquet, New York Athletic Club, New York. Contact: 201-246-7271.

18-20—Communications Marketing Conference, Denver. Contact: CMA secretary-treasurer John Ehret, TPL Communications, 213-256-3000.

1990

January

29-30-American SMR Network Association Winter Meeting and Exposition, Hyatt San Antonio, San Antonio, TX. Contact: 202-331-7773.

February

5-7—Cellular Telecommunications Industry Association 1990 Winter Meeting and Exposition, Ballys, Reno, NV. Contact: 202-785-0081.

March

11-14-Energy Telecommunications and Electrical Association '90, San Antonio Convention Center and Hilton and Marriott hotels, San Antonio, TX. Contact: 214-578-1900.

22-24—Telocator Spring International Convention, San Diego Convention Center, San Diego, CA. Contact: 202-467-4781.

28-30-International Mobile Communications Expo, Dallas Convention Center, Dallas. Contact: 303-220-0600.







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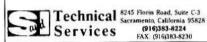
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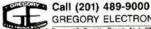
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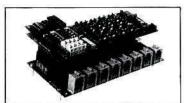
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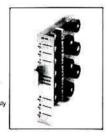
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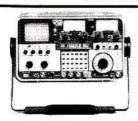
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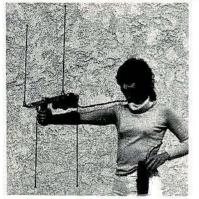
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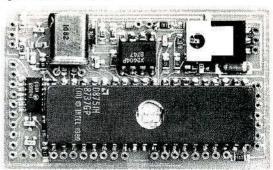
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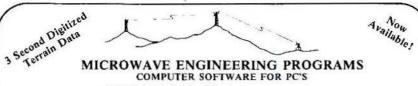
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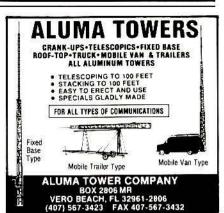
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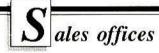
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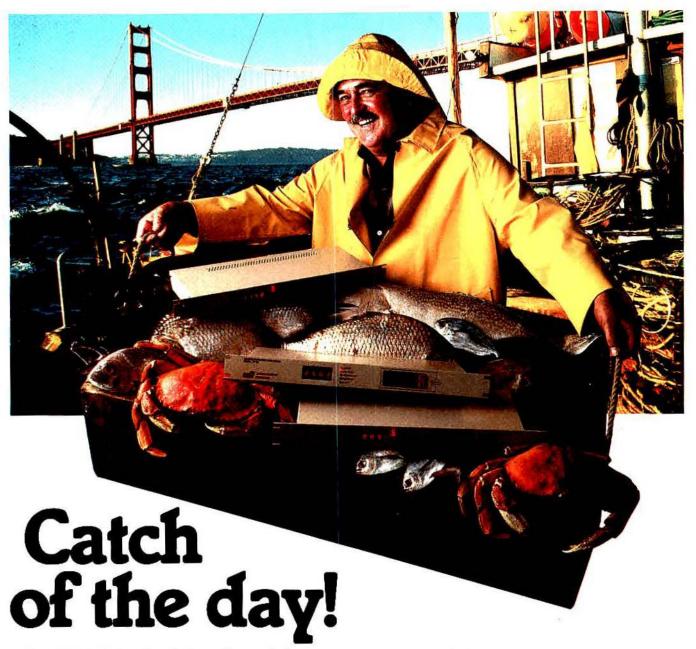
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